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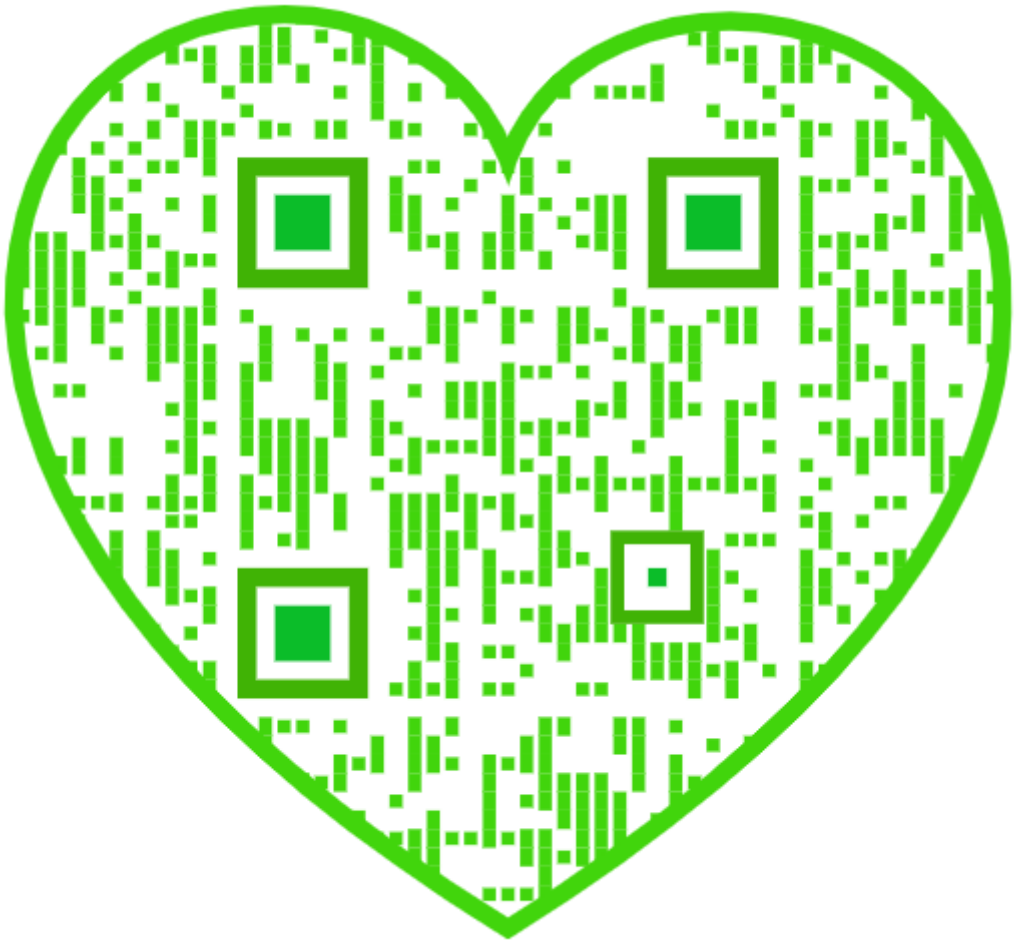

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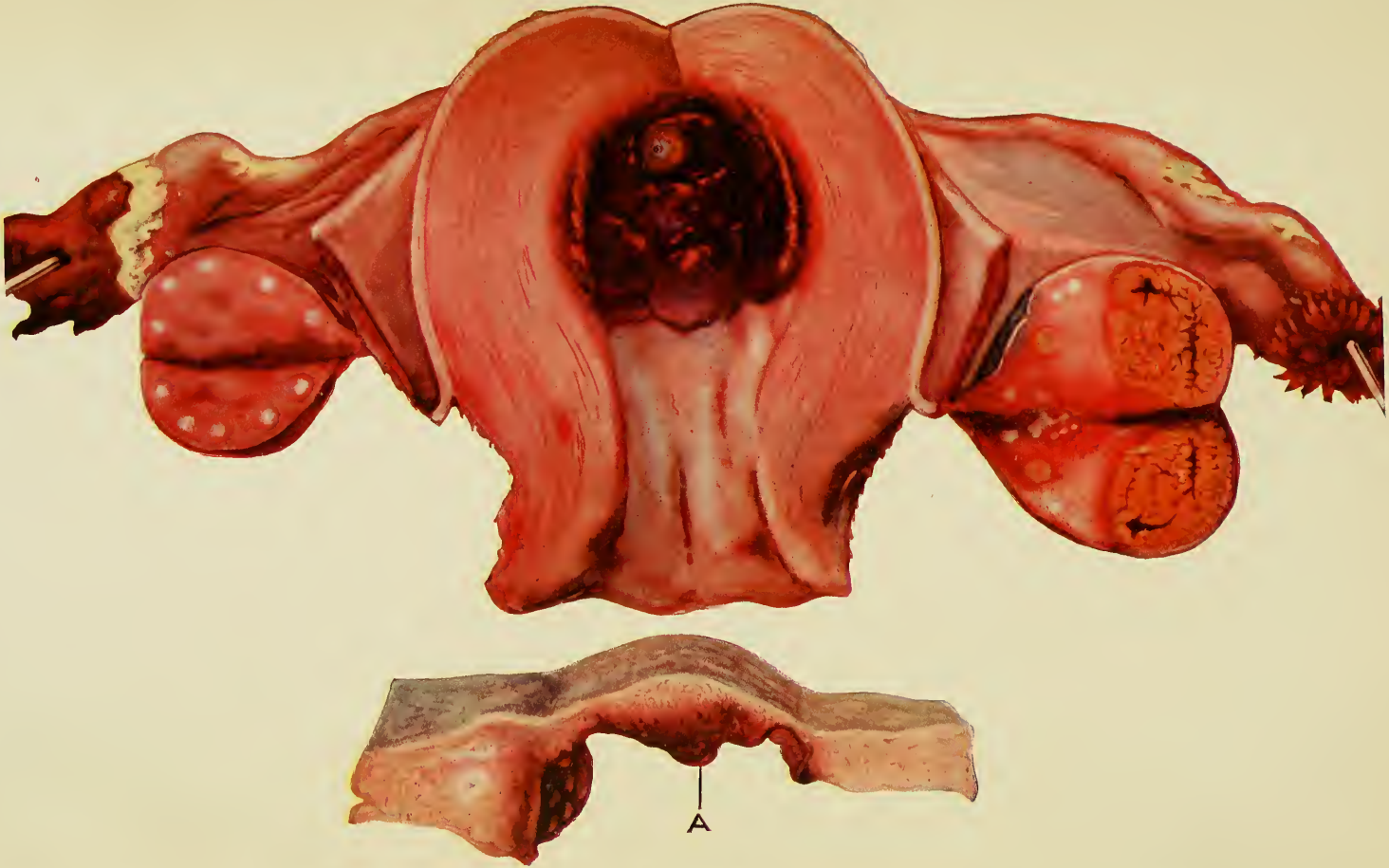
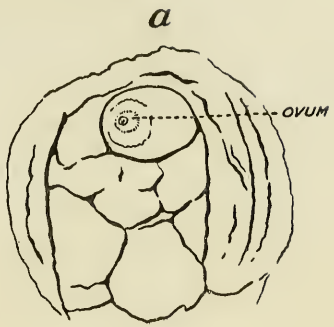


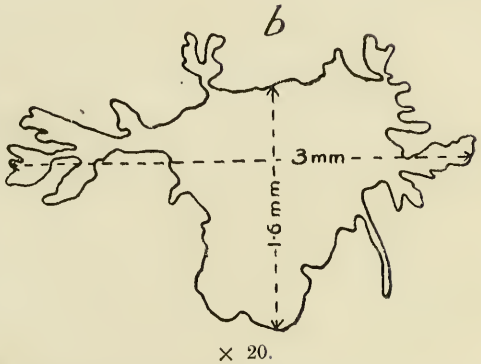
PLATE I.—Gravid Uterus removed *post mortem* from a case of Suppurative Appendicitis. An early ovum was found *in situ* measuring 1·16 × 3·0 mm. in diameter The lower figure represents a transverse section through the uterus at the level of the implantation site. (From the collection of Dr. Cuthbert Lockyer.)

(a) Outline of ovum embedded in the decidua. The ovum corresponds to the point A in the coloured plate.

(b) Outline of the chorionic sac showing the distribution of the early villi.

(*a*) Outline of ovum embedded in the decidua. The ovum corresponds to the point A in the coloured plate.





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(*b*) Outline of the chorionic sac showing the distribution of the early villi.

PRACTICAL

OBSTETRICS

BY

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FOURTH EDITION

WITH 5 PLATES AND 354 ILLUSTRATIONS IN THE TEXT

ST. LOUIS
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1915

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PREFACE TO THE FOURTH EDITION

IN preparing the present edition of this Manual a further increase in size has been found necessary in order to include the advances in various subjects which have been made during the last three years.

The introduction of Abderhalden's Test, and the progress which has been made in our knowledge of the pregnancy-changes in the endocrinous glands, has altered the aspect of the General Physiology of Pregnancy so much that this section has been entirely re-written. The description of the Toxæmias of Pregnancy, and of the obstetric treatment of Eclampsia, has also been completely revised.

The valuable work of British obstetricians in recognising and explaining the Local Contraction Ring as a cause of obstruction in labour has been taken advantage of, and an attempt made to classify the different varieties of over-action of the parturient uterus. The treatment of Placenta Prævia has also been completely revised.

Four coloured plates are included in this edition, which it is hoped will be of service to students making their first

acquaintance with the conditions illustrated. I have to express my thanks to my colleague, Dr. Cuthbert Lockyer, for permission to make use of two interesting specimens in his collection, and to Dr. Hubert M. Turnbull, of the London Hospital, for the microscopic preparations represented in Plate III.

Thos. Watts Eden.

26, Queen Anne Street, W.
1915.

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Part I.

NORMAL PREGNANCY.

Ovulation

The ovary is the storehouse in which egg-cells (oocytes) are preserved, and from which they are periodically liberated during the years comprised between puberty and the menopause. *Ovulation* is the process by which oocytes are discharged from their protecting chambers—the Graafian follicles—into the peritoneal cavity ; this process includes the two stages of maturation (ripening) and dehiscence (rupture) of the follicles. A follicle in the resting phase (*i.e.* before ripening has commenced) lies deeply in the cortical layer of the ovary, separated from the surface by a stratum of ovarian tissue of variable thickness. In the ripening process two changes occur : (1) it first approaches the surface, and finally becomes partly extruded, forming a protuberance on the ovary, the germ-epithelial covering at that spot being lost ; (2) it increases greatly in size. The structure of a ripening follicle is shown in Fig. 1. The process of extrusion has not been fully studied, but there occurs an undoubted displacement of the enlarging follicle towards the surface. The causes of rupture are also obscure and probably complex, and many different views concerning them have been advanced. A great increase in the amount of liquor folliculi occurs during maturation, partly by transudation from the congested ovarian vessels, and partly perhaps by secretion from the proliferating cells of the granulosa ; towards the end of the process hæmorrhage may also occur into the follicle, causing a sudden increase in tension which would easily determine rupture. Clark has pointed out that there is great proliferation of the granulosa cells during ovulation, which he believes also increases the intra-follicular tension. In addition, degenerative processes of the nature of necrosis occur in that part of the wall of the follicle which lies exposed

upon the surface, and is unsupported by the ovarian stroma, which so weaken it that it is unable to resist the high tension within, and rupture results. Rupture is therefore due to weakening from degeneration of the wall of the follicle, combined with increased intra-follicular tension.

When the follicle ruptures, the contained fluid escapes and

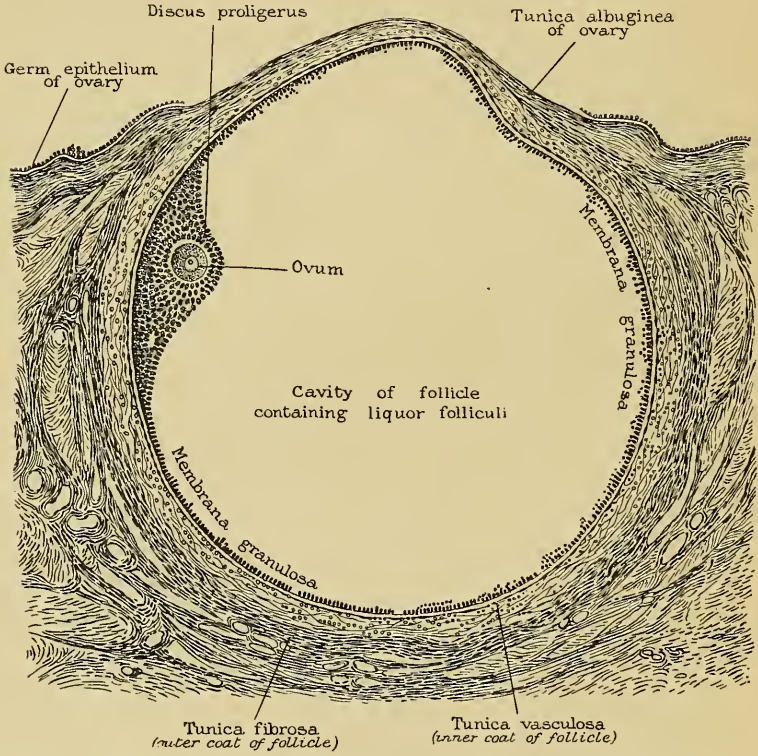


FIG. 1.—Ripening Graafian Follicle protruding upon the Surface of the Ovary. (Bumm.)

as a rule carries the oocyte with it into the peritoneal cavity. The discus proligerus is usually, but not always, attached to the deepest part of the wall of the follicle. Nagel has shown that fatty degeneration of the granulosa cells occurs during maturation, and this, by weakening the attachments of the oocyte, no doubt assists its liberation and escape from the follicle. Occasionally two and sometimes three oocytes are found in a Graafian follicle. Sometimes Graafian follicles

may rupture without detachment of the oocyte occurring ; this gives the opportunity for ovarian pregnancy to arise if spermatozoa should chance to enter the ruptured follicle (see p. 169) ; otherwise the oocyte would perish *in situ* and non-detachment thus become a possible cause of sterility, but we have no definite information upon this point. The human oocyte is a large cell, 200μ in diameter, consisting of the zona pellucida or striata (cell-envelope), the vitellus or yelk consisting of coarsely granular protoplasm (cell-body,

FIG. 2.—Human Oocyte showing the Corona Radiata, Zona Radiata, Granular Protoplasm, Germinal Vesicle, and Germinal Spot. (Van der Stricht, from Galabin and Blacker.)

cytoplasm), the germinal vesicle (nucleus), and the germinal spot (nucleolus). An oocyte sometimes contains two nuclei, and the nucleolus is not infrequently double. The human oocyte, after its escape from the follicle, is shown in Fig. 2 ; it retains a covering of several layers of cells derived from the discus proligerus, which serve to protect it during its transit to the Fallopian tube ; in the tube this protective covering disappears. The cells forming the *corona radiata* are merely somewhat specialised cells of the same origin as those of the discus proligerus.

After its discharge from the ovary the oocyte migrates into

the Fallopian tube. It was at one time thought that during ovulation the fimbriæ of the abdominal ostium became turgid like erectile tissue and spread over the ovary like the fingers of the hand, so that the ovum was discharged directly into the mouth of the tube itself. This view appears to rest upon fancy, and is opposed to established clinical facts. We know now that the oocyte does not always enter the Fallopian tube of the same side, but may pass across the pelvic peritoneal cavity and enter the opposite tube. This phenomenon, known as 'external wandering,' has been demonstrated by cases in which a woman has become pregnant after losing the ovary of one side and the tube of the other; the discharged oocyte must, in such cases, pass across the pouch of Douglas. The distance between the ovary and the mouth of the opposite Fallopian tube is not great, and may be reduced by the pelvic congestion accompanying ovulation. The oocyte has no locomotive power of its own, and must be carried by peritoneal currents from the ovary to the tube. There is no difficulty in believing that such currents exist in the neighbourhood of the abdominal ostia, for the cilia covering the mucous surfaces of the fimbriæ work towards the uterus and naturally set up currents travelling in that direction in the thin layer of fluid which covers the peritoneum. Their existence in lower animals has been actually demonstrated by injecting insoluble particles into the peritoneal cavity; some of these have afterwards been found in the tubes, having been carried thither by peritoneal currents. When once the oocyte has reached one of the tubal fimbriæ, it is probable that peristaltic contractions of the tubal muscle play a part even more important than ciliary action in passing it on to the uterus.

After the Graafian follicle has ruptured and discharged its contents, it undergoes important changes and is henceforth termed the *corpus luteum*. A great deal of attention has recently been paid to both the structure and the functions of this body, and there is some evidence accumulating that it may normally exert a certain controlling influence upon pregnancy, and that morbid conditions of the developing ovum within the uterus, and of the corpus luteum in the ovary, frequently co-exist.

The cavity of the ruptured follicle is at first filled up with blood effused from the site of rupture ; the degenerated granulosa cells are mostly cast off, their place being taken by many layers of actively proliferating polygonal cells of epitheloid character in which a yellow pigment called lutein has appeared. These cells are therefore now called *lutein cells*. So well marked are their characters that their presence in a structure of indeterminate nature is sufficient to prove it to be active ovarian tissue. They arise either from the

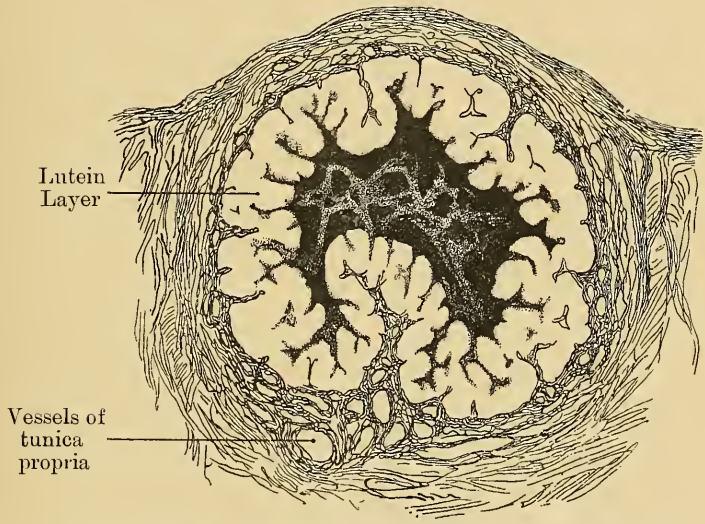


Fig. 3.—Corpus luteum three weeks after Menstruation, showing the Central Blood-clot, the Convoluted Lutein Layer, and the Vascular Tunica Propria. (Bumm.)

connective-tissue cells of the tunica vasculosa or from the membrana granulosa. Each of these views has its advocates, but the more recent observations have been unanimously in favour of their origin from the follicular epithelium. Owing to the collapse of the follicle after evacuation of its contents the wall becomes convoluted along its entire length from the formation of folds, and the lutein layer thus comes to acquire its characteristic sinuous outline (Fig. 3). Subsequent changes consist in the absorption of the central blood-clot, the complete occlusion of the cavity by proliferating lutein cells, and gradual shrinkage of the entire body. It has

been recently shown that masses of lutein cells can often be found scattered through the ovarian stroma during pregnancy, so that their function is probably not limited to the repair of the ruptured Graafian follicle. Soon the lutein cells undergo a kind of hyaline degeneration, losing their nuclei and cell outlines, and becoming transformed into structureless masses. These masses in turn are replaced by connective tissue which invades them from the surrounding ovarian stroma ; at this stage it is usually called the *corpus fibrosum* or *corpus albicans*. Frequently the corpus albicans becomes divided into portions by ingrowing strands of stroma, so that a considerable number of white bodies, isolated from one another, may be found in an adult ovary. Finally all trace of lutein cells disappears, and only a small depressed cicatrix remains upon the surface of the ovary to indicate the previous existence of the corpus luteum. The length of time occupied by these changes is variable, becoming longer as age advances ; many weeks or months are probably always required for their completion.

During pregnancy the corpus luteum attains a greater size than when pregnancy does not occur ; it may continue to increase in size, probably from progressive hæmorrhage, for three or four months, and may come to occupy about one-third of the whole ovarian area. It then gradually undergoes the retrograde changes just described, which are not completed until after the termination of gestation. The large corpus luteum met with in pregnancy was formerly called the ' true corpus luteum,' and that formed when pregnancy does not occur the ' false corpus luteum.' Since there is no essential difference between them, either in structure or in the changes they undergo, these names are meaningless ; the one is no more ' false ' nor ' true ' than the other.

Menstruation

It is undoubtedly true that the processes of ovulation and menstruation are closely related to one another ; but whether they are coincident or consecutive, and, if consecutive, which precedes the other, we do not know with certainty. That menstruation is not essential to the occurrence of pregnancy, and that a fertilised ovum may be successfully implanted

upon a quiescent endometrium, is well known ; for pregnancy may occur either before the establishment of the menstrual function at puberty, after the menopause, or during a temporary suspension of menstruation such as that

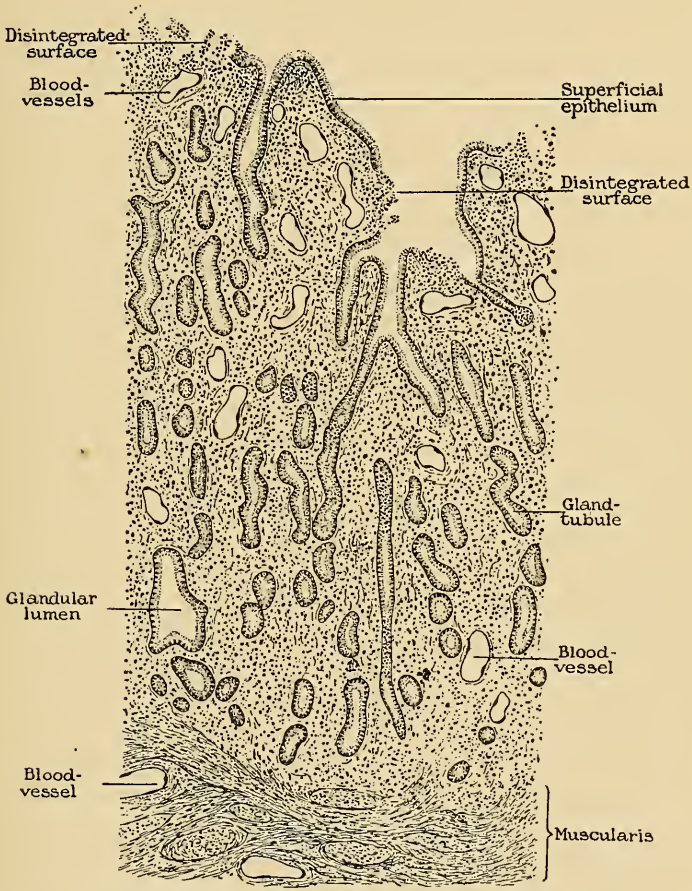


Fig. 4.—Vertical Section of Endometrium during the First Day of Menstruation. (Schäfer.)

which usually accompanies lactation. There is, however, much to be said for the time-honoured view that the uterus is in some way prepared by the menstrual changes for the reception of the fertilised ovum ; for regularity of the menstrual function is the rule in fertile women, and clinical

observations indicate that conception, although it may occur at any point in the menstrual cycle, is most likely to occur during the days which immediately follow a menstrual period. From careful clinical observations upon cases in which the ovaries were examined in the course of operations, Fraenkel has expressed the opinion that ovulation ordinarily occurs soon after the close of a menstrual period. This view also receives support from the fact that the changes which the uterine mucous membrane undergoes during menstruation present certain well-marked resemblances to those which immediately follow upon conception and result in the formation of the decidua. So marked is the resemblance that many writers now speak of the endometrium during menstruation as the *menstrual decidua*.

The anatomy of menstruation has been recently studied by Gebhard, Sellheim, and others in human uteri removed during a menstrual period. The earliest changes appear to be hyperæmia and swelling of the mucosa, associated with engorgement of blood-vessels, which is most marked in the superficial capillaries (Fig. 4). The glands become elongated and irregularly dilated, presenting a somewhat corkscrew outline ; when seen in longitudinal section the dilated lumen is irregularly divided by transverse septa upon which proliferating epithelium is seen ; the inter-glandular connective tissue increases in amount, becomes looser in texture, and sometimes shows traces of infiltration with leucocytes (pre-menstrual phase). A little later small interstitial hæmorrhages appear, situated chiefly beneath the superficial columnar epithelium, and as a result patches of these cells become thrown off ; but the amount of tissue lost in this way is very small. It is uncertain whether the hæmorrhages are due to diapedesis, or to degeneration and rupture of the walls of the capillaries. The menstrual flow comes in part from the denuded patches, but probably the whole of the greatly congested mucosa bleeds more or less. In addition a large amount of mucus is produced by the active glands, and this substance forms a considerable part of the bulk of the menstrual fluid. There is no formation of large cells in the connective tissue, such as occurs in pregnancy. The mucous membrane of the cervix takes little or no part in these changes. If an ovum becomes fertilised, further important

developments occur in the endometrium, resulting in the formation of the decidua of pregnancy ; if not, the congestion subsides, the damaged surface is repaired, the glands become inactive, and the mucous membrane passes again into the phase of quiescence.

The most important difference between the mucosa during menstruation and the decidua of pregnancy is the formation in the latter of the characteristic decidual cells ; in most other respects the resemblance between them is striking.

Fertilisation and Implantation

The process of fertilisation consists in the union of the male element (spermatozoon or male gamete) with the female element (oocyte or female gamete). From what we know of the process in lower mammals there is reason to believe that the spermatozoon and oocyte usually meet in the Fallopian tube. We have seen that the oocyte may be carried into the tube by peritoneal currents and then passed on by the action of the ciliated epithelium and tubal muscle. The spermatozoon makes its way upwards from the vagina by means of the propelling apparatus with which it is provided, consisting of a long tail which acts like a paddle in driving it forward through the thin layer of fluid which covers the mucous membranes. The activity of the spermatozoa is very great in certain animals, for they can travel from the vagina into the peritoneal cavity in a few hours. It is somewhat doubtful whether their progress is opposed by the action of the ciliated epithelium, for the existence of ascending currents in the secretions of the genital tract has been demonstrated by Bond, who placed insoluble particles of colouring-matter in the vagina, and recovered them in the Fallopian tube on operation a few days later. The time occupied by the transit through the tube in the human species is unknown, but from comparative observations, it is believed not to exceed twenty-four hours (Teacher). It is possible for spermatozoa to lie in wait for the oocyte in the Fallopian tube for considerable periods ; thus they have been found alive in a human Fallopian tube removed three and a half weeks after the last act of sexual intercourse. Only one spermatozoon is required for the fertilisation of an

oocyte, and of the enormous numbers found in the seminal fluid nearly all must perish without achieving their physiological destiny. The fertilised egg-cell is termed morphologically the *zygote ;* clinically it is convenient to call it the *ovum*, a term which may be applied at all stages of its development.

The details of the process of fertilisation naturally cannot be studied in the human species ; most of what we know

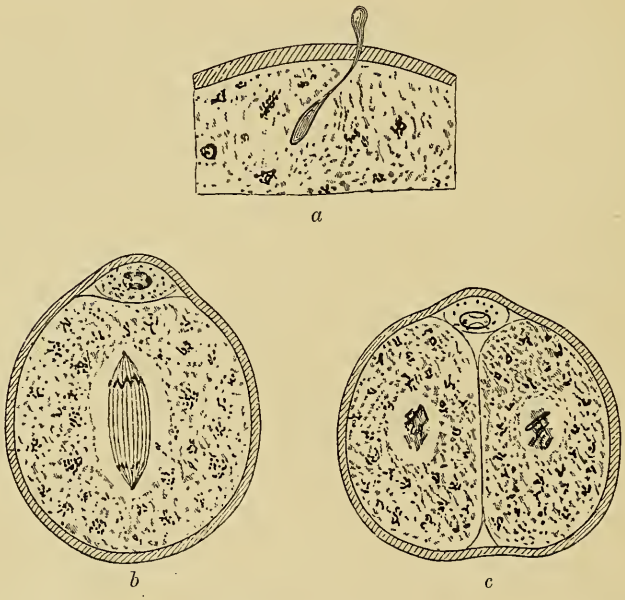


Fig. 5.—The Process of Fertilisation in the Mouse, after Sobotta. (Von Winckel.)

a. Penetration by a spermatozoon. *b*. Formation of polar body, and first division of segmentation nucleus. *c*. Binary division of the ovum.

comes from observations upon certain of the echinoderms and ascarides which possess transparent oocytes, but Sobotta has recently succeeded in studying fertilisation in the mouse. The matter can only be very briefly referred to here.

Immediately before the union of the spermatozoon and oocyte, certain changes occur in the nucleus (germinal vesicle) of the latter, resulting in the extrusion of one or two minute portions of its substance, with a covering of protoplasm, beneath the zona radiata ; the extruded portions are termed

the polar globules, but their significance is quite unknown, and they soon disappear. The polar globules carry with them one half of the chromatin loops (or chromosomes) which the germinal vesicle originally contained; consequently the latter when fertilised contains only one half of its proper number. It is possible that this process determines the occurrence of variations in hereditary characters. As the human oocyte possesses no micropyle, such as exists in the invertebrates, the spermatozoon penetrates (Fig. 5, *a*) the zona radiata (*z. pellucida*), and when the head has entered, the tail separates and disappears. The human egg-cell is a large cell 200μ in diameter, and visible to the naked eye; the head of the spermatozoon measures about 5μ in length. Attention has recently been paid to the behaviour of the nuclei during fertilisation, and observations on lower animals have established the following facts. The included head of the spermatozoon (*male pronucleus*) and the germinal vesicle of the ovum (*female pronucleus*) each divides into two, and active karyokinetic changes occur. After an interval the four nuclei fuse to form a single nuclear spindle to which an equal number of chromatin loops (*chromosomes*) is contributed by the male and female pronuclei. Every cell formed from the fertilised ovum therefore contains chromosomes derived originally from each parent (Adami).

The cell resulting from fusion of the two pronuclei is the *fertilised ovum* or *zygote*. The fertilised ovum now starts immediately upon a career of extraordinary activity by which all the organs and tissues of an individual human body are formed from it by cell-division and differentiation. The process of cell-multiplication in its earliest stages is known as the *segmentation* of the ovum. The segmentation nucleus first divides into halves, which recede towards opposite poles of the cell (Fig. 5, *b*); an equatorial or polar line of division is then formed between them which divides the entire cytoplasm in two (Fig. 5, *c*). The same process is repeated in the two new cells, and being continued indefinitely, the ovum multiplies by binary division into 2, 4, 8, 16, 32, &c., cells. In this manner a solid cluster or globe of cells is formed, called the *muriform body*. This body next becomes converted into the *blastodermic vesicle*

or *blastocyst* by the formation of fluid in the centre, which greatly increases its size, and by excentric pressure causes the cells to become flattened and arranged around the periphery. This process has been described by Van Beneden in the rabbit (Fig. 6). He found that at first the wall of the blastocyst consisted of two layers of cells, the outer complete, the inner incomplete ; later a third layer of cells was developed between these two where they were in contact. These three layers of cells constitute the *trilaminar blastoderm*, and from them all the tissues of the body are subsequently developed. The outer is called the ectoderm, the inner the entoderm, the middle layer the mesoderm. In man the primitive ectoderm is of great importance, and is specially designated as the *trophoblast* (*vide infra*). Immediately preceding the appearance of its third layer a small area of thickening is formed upon the ectodermic layer of the blastocyst, which is the first indication of the body of the future embryo, and is called the *embryonic area ;* a shallow longitudinal groove soon appears along this area, which is the first foreshadowing of the vertebral column, and is called the *primitive groove*. The embryonic area, with its primitive groove, represents that portion of the ectoderm which is alone concerned in the formation of the body of the embryo ; it is known as the *embryonic ectoderm ;* the remainder plays a different part, and it is with this portion that we are now chiefly concerned. Text-books of embryology must be referred to for a fuller description of the foregoing stages and for an account of the development of the epidermal, skeletal, and visceral systems ; but the fate of the *extra-embryonic* portion of the ovum is intimately concerned with the nutrition and development of the

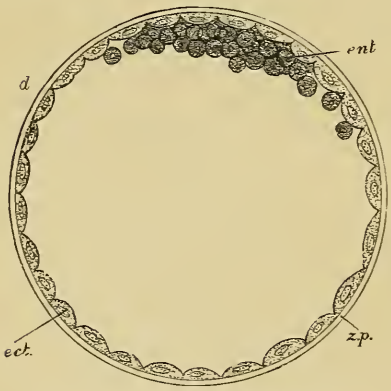


Fig. 6.—Bi-laminar Blastodermic Vesicle of Rabbit. (Van Beneden.)

ect. Ectoderm cells. *ent.* Entoderm cells. *z.p.* Zona pellucida.

fœtus *in utero*, and is therefore of immediate importance in obstetrics.

At this stage of development begins the formation of the special fœtal envelopes, the *chorion* and *amnion*, which fulfil the double functions of nutrition and protection throughout the whole period of intra-uterine life. In the earliest human ova which have been described, viz. those of Bryce-Teacher and Peters, the formation of these membranes has already commenced. They appear in the human species probably much earlier (relatively) than in birds—the creatures in whom their development has been most carefully studied.

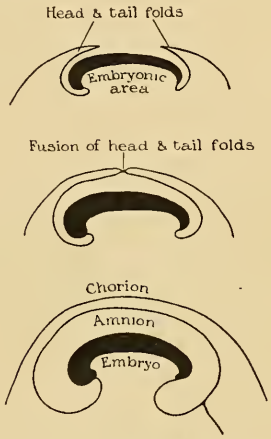


FIG. 7.—Scheme of Development of the Amnion and Chorion in the Chick. (Von Winckel.)

The development of the fœtal envelopes in the chick is as follows. Chorion and amnion are developed together, and subsequently differentiated for the special functions they have to fulfil. They are formed from folds which spring up from the head and tail ends, and lateral boundaries, of the embryo, and grow over its dorsal surface. These folds consist of a double layer of epiblast cells with mesoblast cells between them. The inner layer of the blastoderm (hypoblast) takes no share in the process. Gradually they coalesce, producing a membrane which has the form of a closed hood ; it consists of a central layer of mesoblast cells, covered externally and internally by a layer of epiblast cells (Fig. 7). This single membrane now splits into two, the line of cleavage passing through the centre of the mesoblast layer. Thus two membranes are formed, the outer (further from the embryonic area) having an external epiblastic covering, the inner having an internal epiblastic covering ; the former is the *chorion*, the latter the *amnion*.

Recent observations upon the development of lower mammals have led to the belief that a different mode of development of the fœtal membranes occurs in them, and

the appearances found in the earliest human ova described make it probable that this mode of development obtains in man also. This method is diagrammatically represented in

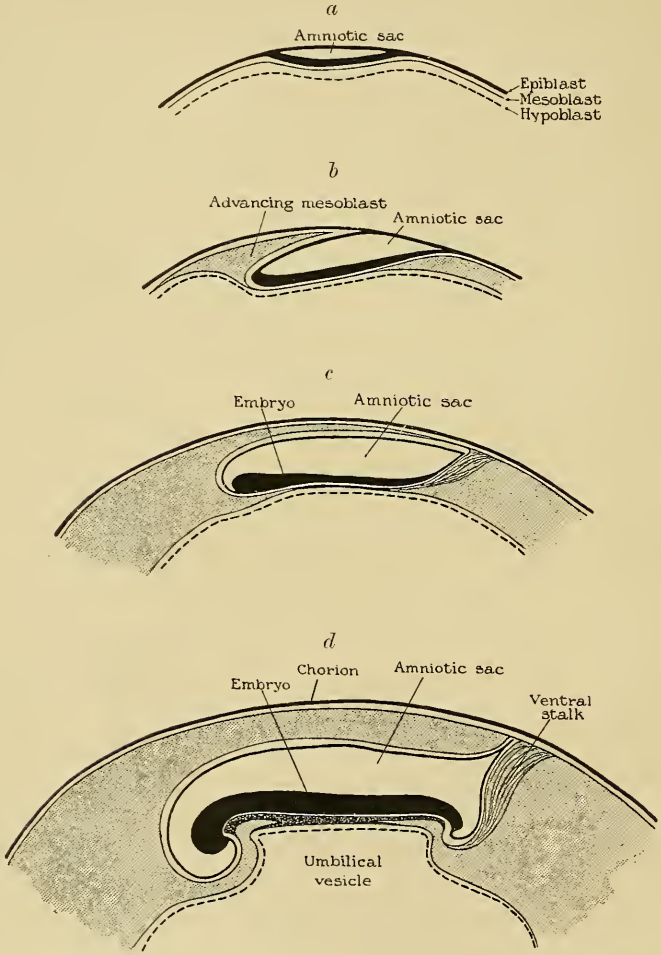


FIG. 8.—Scheme of Development of the Amnion in Lower Mammals, and probably in Man. (Von Winckel.)

Fig. 8. Upon a part of the surface of the blastodermic vesicle the epiblast splits, forming a small space enclosed by epiblast cells; this represents the earliest sign of the amniotic sac (Fig. 8, *a*). At the extremities of this space the meso-

blast cells proliferate, but more markedly at one end than the other. The epiblastic floor of this primitive amniotic cavity corresponds to the *embryonic area*, and the special proliferation of the mesoblast takes place at the end which ultimately becomes the head of the embryo. The mesoblast cells at the head end now penetrate the roof of the amniotic cavity and split it into two layers, the process gradually passing over to the tail end (Fig. 8, *b*, *c*). In this way the amniotic cavity becomes completely cut off by mesoblast cells from the epiblast wall of the blastodermic vesicle. The body of the embryo has by this time become outlined, and, with its amnion and umbilical vesicle, sinks away from the surface ; the layer of mesoblast which has formed over the amnion splits in two, and becomes attached in part to the wall of the blastodermic vesicle, in part to the amnion. The blastodermic wall, consisting now of an outer epiblastic and an inner mesoblastic layer, becomes the chorion ; the zona pellucida has disappeared. The embryo, with its amnion and umbilical vesicle, would now lie free in the interior, but for the fact that a mesoblastic stalk attaches its tail end to the wall of the blastodermic vesicle ; this represents the ventral stalk (Fig. 8, *c*, *d*). Thus are formed two embryonic coverings ; the inner, or *amnion*, is closed from the outset and is cut out of the primitive epiblast ; the outer represents the primitive epiblast wall of the blastocyst with its mesoblast lining, and ultimately this layer becomes the chorion.

When this method of development obtains, the early embryo is in this way cut off—except where the ventral stalk is formed —from the periphery of the developing ovum. It carries with it a certain supply of nutritive material contained in the umbilical vesicle. This structure represents the inner entodermic layer of the blastocyst cut off from the periphery by the proliferation and splitting of the mesoblast layer. In birds and reptiles the umbilical vesicle is of large size and no doubt plays an important part in nutrition ; in man and most other mammals it is small and unimportant. As we shall immediately see, changes occur at a very early period in man by which the ovum is enabled to obtain the nutriment it requires directly from the maternal tissues.

The earliest stages of development which have been observed in human ova appear to correspond approximately to the stage which has just been described. A human ovum from a case of complete abortion has recently been described by Bryce and Teacher which represents an earlier stage of development than any previously described. This ovum is shown in its containing strip of decidua in Fig. 9. Circumstances were unusually favourable for the determination of the date of conception, and according to the authors the period of development may authoritatively be placed at about fourteen days, the limits of probability being twelve to fifteen days. Before the description of this specimen, an ovum described by Peters was believed to be the earliest, and this was estimated by him at three to four days' development only. But the Bryce-Teacher ovum is obviously an earlier stage than the Peters ovum, and it is certain that the period of development of the latter has been greatly under-estimated; this is accounted for in part by the absence, in Peters' case, of exact clinical data, the specimen being a post-mortem one from a case of suicide. From this point onwards we can accordingly proceed upon the results of direct observation upon the human ovum instead of following the doubtful guidance of comparative embryology.

FIG. 9.—Bryce-Teacher Ovum with the portion of decidua in which it was imbedded. The prominent oval lobule is the site of implantation. (Bryce and Teacher.)

The general structure of the Bryce-Teacher ovum is diagrammatically represented in Fig. 10, and that of Peters in Fig. 11; both correspond to a stage considerably further advanced than the blastocyst shown in Fig. 6. The cells of the primitive ectoderm have proliferated and now form a reticulated layer; the amnion has been cut off and included, probably in the manner described by Sobotta. The cells of the entoderm have not proliferated to the same extent as those of the ectoderm, and the entodermic vesicle

is of relatively very small size. In the figure the mesoderm forms a solid mass of cells filling the central part of the ovum and surrounding and separating the entodermic and amniotic vesicles. At a later stage, when the ovum has grown larger, the mesoderm splits into two layers, the outer going with the trophoblast to form the chorion, the inner going with the amnion and the entodermic vesicle. The sinking of the amniotic vesicle and embryonic entoderm into the

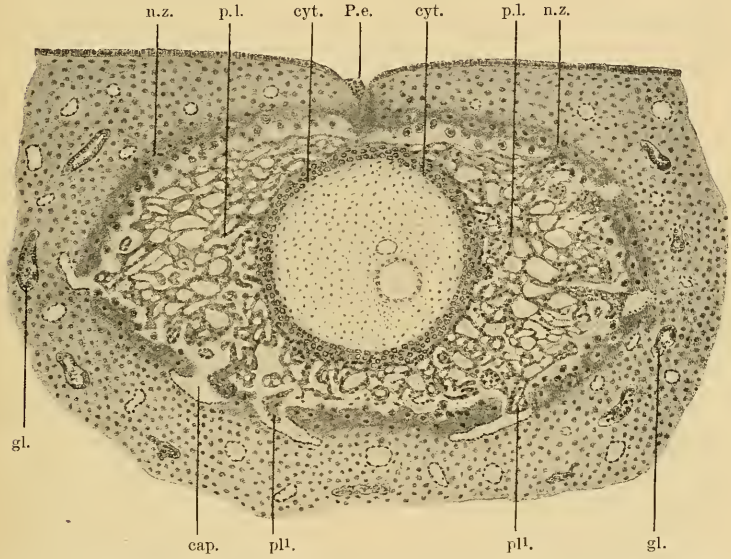


FIG. 10.—Diagram of the Bryce-Teacher Ovum. The cavity of the blastocyst is completely filled with mesoblast cells, and imbedded therein are the amniotic and entodermic vesicles. P.e., point of entrance; cyt., cyto-trophoblast; pl., plasmodi-trophoblast; n.z., necrotic zone of decidua; gl., gland; cap., capillary; pl¹., masses of plasmodium invading capillaries. (Bryce and Teacher.)

interior of the blastocyst is a process which is not at present clearly understood in the human ovum. The relation of the blastocyst to the maternal tissues at this stage is a point of the greatest importance, and the observations of Hubrecht (comparative), of Peters, and of Bryce and Teacher permit of a fairly clear account being now given of what obtains in the human ovum.

The ovum of Bryce and Teacher, and that of Peters, were both found to be completely imbedded in the decidua

Fig. 11.—Peters's Ovum *in situ*.

(Figs. 10 and 11). The point of penetration is represented in the former by a minute depression of the surface where the epithelium is lost, and a small area of blood clot is seen ; in the latter it is represented by a cap of fibrin of considerably larger size. How did the ovum penetrate the decidua and bury itself completely in this way ? The cells of the trophoblast are capable of exerting a destructive action upon the maternal tissues, and thus a bed is excavated in which the ovum lies and within which it further develops. After imbedding, the trophoblast shows extra-

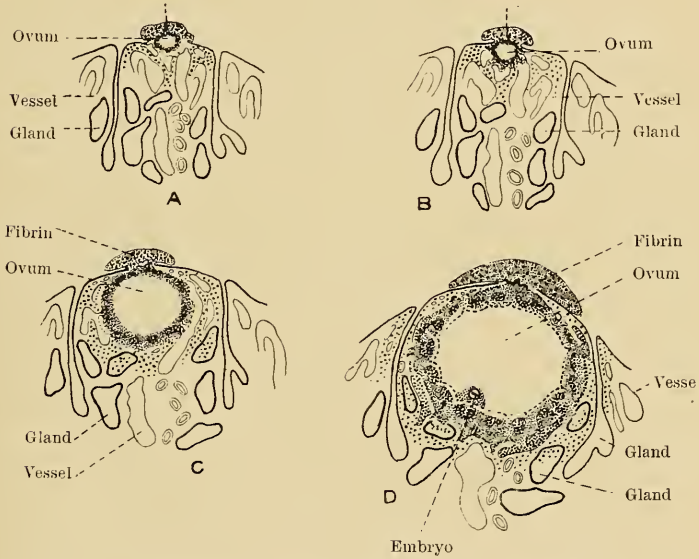


FIG. 12.—Imbedding of the Human Ovum. (Diagrammatic, after Peters.)

ordinary proliferative activity, while the other parts of the blastocyst remain almost quiescent. Not only does the trophoblast area enlarge rapidly, but in it rapid cell-multiplication also occurs, forming a thick stratified layer. In both the Bryce-Teacher and Peters ova the trophoblast is differentiated into two parts, one which consists of nucleated protoplasmic buds, bands, and reticula in which no cell outlines can be distinguished—the *plasmodi-trophoblast* or *syncytium*, and one which consists of definite cells—the *cyto-trophoblast*. The plasmodial bands are arranged around

the blastocyst in the form of a widely spreading network, into the spaces of which pass columns of the cells of the cyto-trophoblast ; in the meshes which, of course, form an inter-communicating system, a quantity of maternal blood is also to be found. The protoplasm of the plasmodi-trophoblast is minutely vacuolated, and by fusion of adjacent vacuoles large spaces are formed in the plasmodia, many of which are seen to contain maternal blood. The space occupied by the trophoblastic network has been excavated in the decidual membrane, and the steps by which the excavation is carried out are shown diagrammatically in Fig. 12. It is believed that this effect is produced by a solvent action exerted upon the maternal cells by a proteolytic ferment produced by the trophoblast. As will be seen later on the maternal tissues in contact with the ovum show evidence of a protective reaction, the object of which appears to be to defend themselves against encroachments.

At the periphery of the trophoblastic zone are to be seen large maternal capillaries which have been penetrated by plasmodia ; the latter appear to have destroyed the endothelium and to have then entered into the lumen of the vessel. This process explains the presence of maternal blood in the spaces of the plasmodial network. This blood does not coagulate, and there is no doubt that it serves to nourish the embryonic structures. After a time the blood begins to circulate through the meshes, although at the beginning of the process it is necessarily stagnant. In this way we see that the nutrition of the ovum from maternal sources is provided for at a very early period of development. The existence of such an arrangement as this in the mammalian ovum was first described by Hubrecht in the case of the hedgehog, and the observations of Bryce and Teacher have demonstrated the occurrence of a precisely similar process in man.

It will be apparent that at this stage the development of the body of the embryo has hardly begun, the blastocyst consisting, apart from the trophoblast zone, of two small vesicles only, one representing the *amniotic vesicle*, an ectodermal structure which has been cut off from the ectodermal layer, and the other a small *entodermic vesicle* which represents the original inner layer of the tri-laminar blastoderm. The space

between them is occupied by a mass of cells representing the mesoderm. The floor of the amniotic vesicle is much thicker than the other parts (Fig. 13), and this small area represents the *embryonic* area (*ectoderm*), and indicates the spot at which the body of the embryo will be laid down. It is visible clearly in the ovum of Peters, but not in that of Bryce-Teacher. It will be recollected that the amniotic and entodermic vesicles remain in connection with the

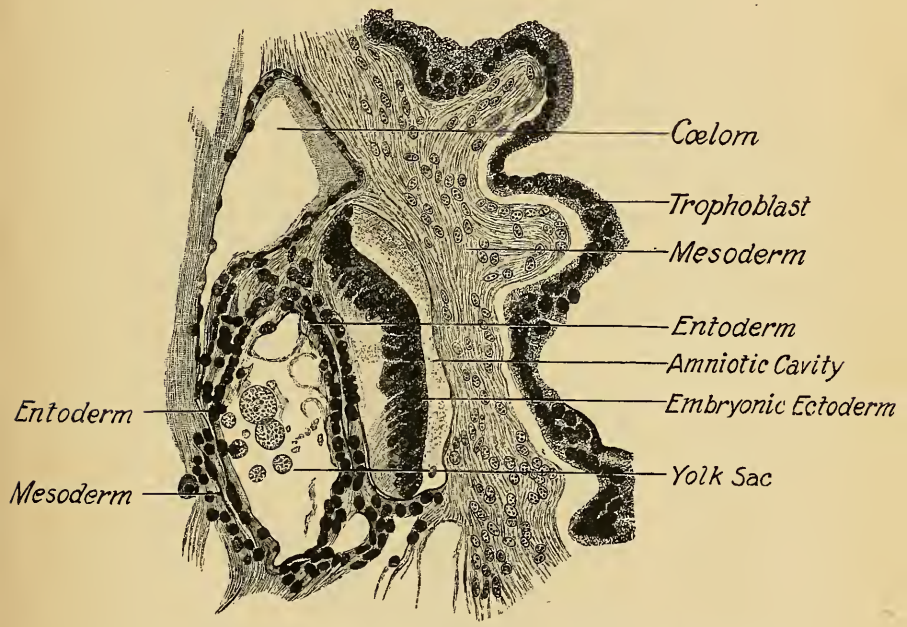


Fig. 13.—Embryonic Area in Peters's Ovum. (Galabin and Blacker.)

trophoblast by a mesodermic process, the ventral or body stalk, not shown in Fig. 11, but represented diagrammatically in Fig. 8. The entodermic vesicle corresponds with the yolk sac, a structure of great importance in the development of birds and reptiles, since it contains a store of nutriment upon which the growing ovum draws. In mammals generally, and especially in man, this structure is unimportant at the present stage, and has little if any nutritive function.

It will now be necessary to consider the maternal structures in which the ovum has found a lodgment.

Under the stimulus of the implantation of the fertilised ovum in the uterus, the endometrium of the whole body of the organ becomes converted into the decidua, but the mucous membrane of the cervix, as a rule, remains practically unaltered (Fig. 14). In a few cases definite decidual for-

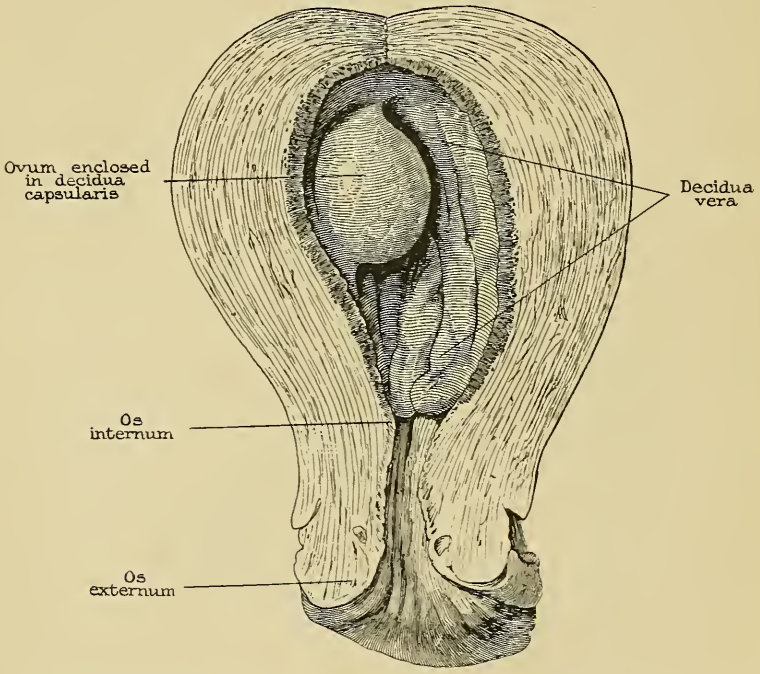


FIG. 14.—Uterus with Ovum of Four Weeks' Gestation. Natural Size. (Bumm.)

mation has, however, been observed in the cervix. This reaction of the endometrium in pregnancy is of great interest and will be referred to again in connection with tubal gestation. As the ovum enlarges, it becomes possible to speak of three distinct portions of the decidua : (1) a large extent of the membrane which is not in direct contact with the ovum at all, called the *decidua vera* (D.V.); (2) a portion in contact with the base of the ovum, called the *decidua basalis* or *serotina* (D.B.); and (3) a portion enclosing the

remainder of the ovum, termed the *decidua capsularis* or *reflexa* (D.C.) (Fig. 15). The term 'decidua reflexa' indicates an old view of the formation of this portion of the membrane, which was that the ovum attached itself to the *surface* of the

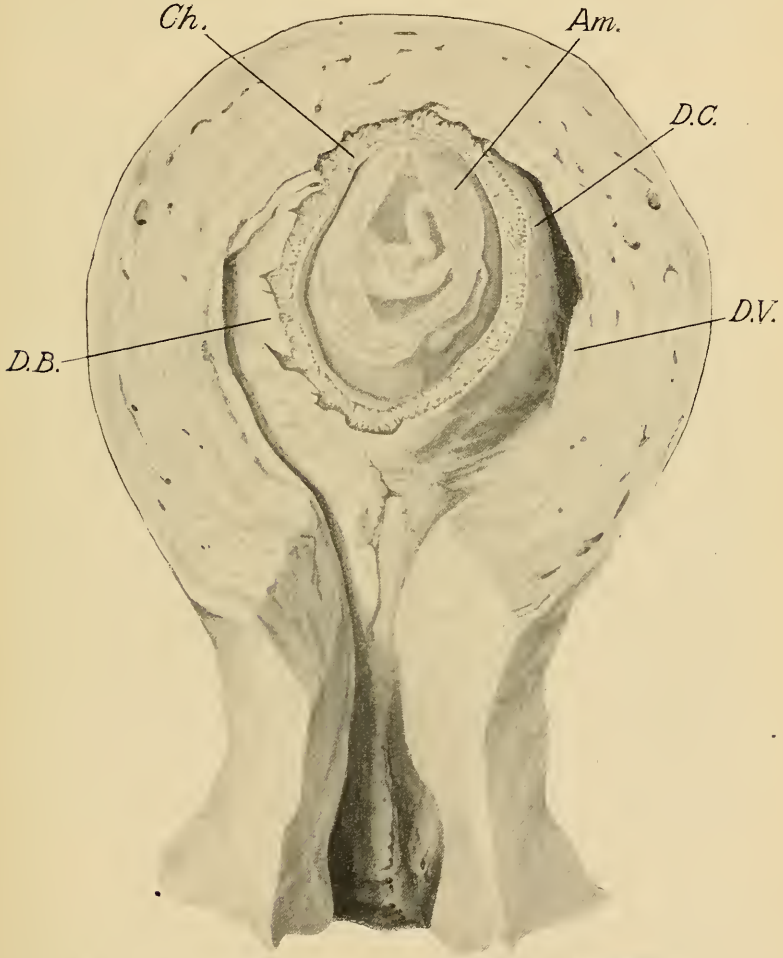


FIG. 15.—Uterus with Ovum of about Ten Weeks' Gestation. (Galabin and Blacker.)

decidua, and later on became enclosed by the growth of a ring of decidual tissue around it, which, ultimately meeting over the free pole of the ovum, completely enveloped it. We now know that no such process occurs ; the ovum is imbedded in

the decidua from the outset ; decidua and ovum develop *pari passu* in this position, thus preserving the original relation ; and ' decidua capsularis ' is therefore a better term than ' decidua reflexa.' The decidua basalis is the area upon which the placenta is subsequently formed in the great majority of instances, although exceptions occur which will be referred

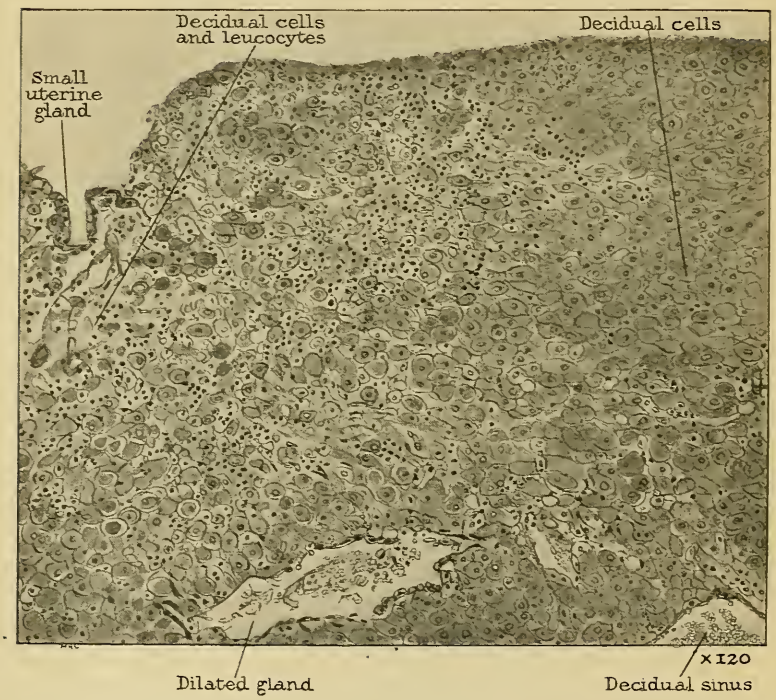


FIG. 16.—Decidua Vera ; Compact Layer. To the right of the figure the decidual cells are closely packed and polygonal ; to the left they are looser, and oval or globular.

to later on. The word ' serotina ' expresses the view of William Hunter that the ovum entered the uterus from the tube beneath the decidua, raising it up from the wall of the uterus ; later on a new formation of decidua occurred at the base of the ovum (*serotinus*=late). We are unacquainted with the functions of the decidua vera.

All parts of the decidua have the same general structure, and, as has been already noted, the membrane bears a

certain resemblance to the menstruating endometrium. The principal gross change which has occurred is the differentiation of the decidua into two layers, the superficial *compact* and deep *cavernous* layers. The latter rests directly upon the uterine muscle. The deep layer is rendered cavernous by very marked, active dilatation of the deep portions of the uterine

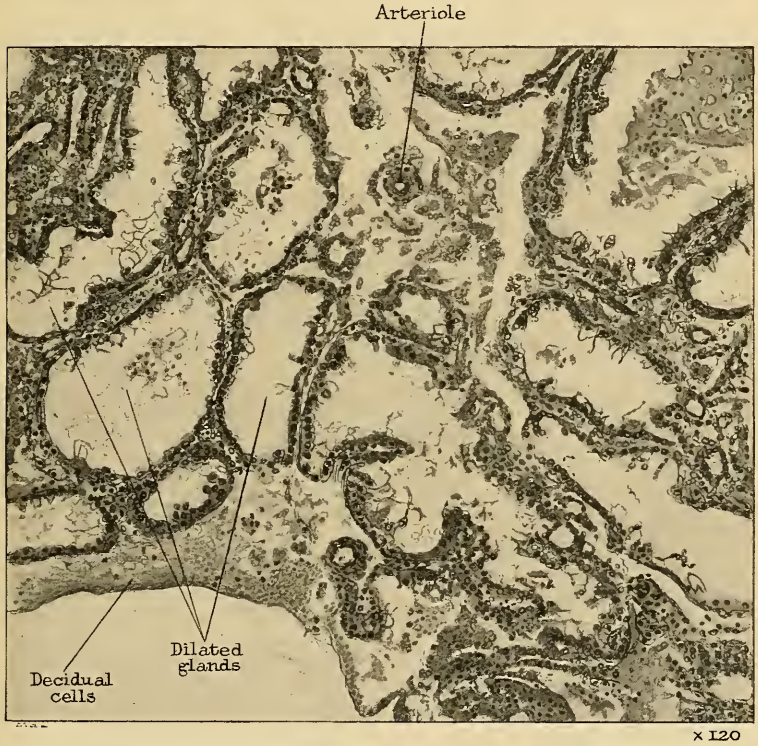


Fig. 17.—Decidua Vera : Cavernous Layer.

glands which form spaces of varied size and shape, with an epithelial lining showing evidences of active cell proliferation (Fig. 17). The superficial layer consists of a compact mass of ' decidual cells ' in which appear here and there dilated capillaries—the ' decidual sinuses ' (Fig. 16). The greater part of the surface epithelium is lost, and very few glands can be seen in this layer. Where chorionic villi come in contact with the decidua certain striking structural changes

occur which will be referred to later on. The cavernous layer is well marked in the decidua basalis, but is not nearly so well differentiated in the other parts of the decidua. The 'decidual cells' are specialised connective-tissue cells; in most situations they are closely packed together and become polygonal from pressure; where the arrangement is looser they assume a spherical or oval shape. Their nuclei are large and globular. Among the decidual cells are seen numerous small interstitial hæmorrhages, and here and there some leucocytic infiltration (Fig. 16). The differences between the decidua and the normal endometrium may be briefly summed up as follows: (1) formation of decidual cells; (2) hypertrophy and dilatation of the deepest portions of the glands; (3) increased vascularity, leading to formation of widely dilated capillaries or 'sinuses,' and interstitial hæmorrhages; (4) extensive loss of the surface epithelium; (5) division into two layers—the superficial compact, the deep cavernous; (6) great increase in thickness —endometrium about $\frac{1}{25}$ of an inch, decidua $\frac{3}{4}$ to $\frac{7}{8}$ of an inch.

The decidua vera increases progressively in thickness until it attains its maximum at about the end of the second month. By the end of the third month the decidua capsularis and decidua vera have been brought into apposition with one another by the rapid increase which has taken place in the size of the ovum. It appears probable that during the early months the decidua exercises a certain protective function towards the maternal organism. It arrests the invasion of the trophoblast, and the active cellular reaction which occurs later on wherever chorionic villi meet it (*vide infra*), is probably to be understood as a protective reaction. The main function of the decidua, however, is to afford a nidus in which the ovum may be imbedded and thus protected against traumatism, which the delicacy of its structures renders it specially prone to suffer from. During the fourth month these two layers become fused, and at term they have become extensively atrophied from pressure so as to be indistinguishable as a double layer. The decidua basalis becomes the maternal portion of the placenta, but conserves its characteristic appearances in the cavernous layer till term.

Chorion and Placenta

We have now followed the steps which have been demonstrated in the imbedding of the fertilised ovum in the decidua, and in the formation of the trophoblast. These arrangements provide for the nutrition of the ovum at this early stage by bringing its outer covering into direct contact with free maternal blood. The next stage is the formation of the chorion or specialised outer fœtal envelope ; this structure is formed directly from the trophoblast, and accordingly comes to represent, at this stage, the outer ectodermal layer of the primitive blastoderm. The transformation of the trophoblast into the chorion is brought about by the formation of

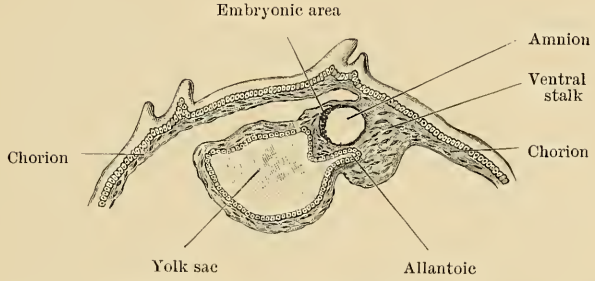


FIG. 18.—Spee's Human Ovum from Early Part of Second Week. (Galabin and Blacker.)

villi which replace the irregular network of plasmodial cells and processes of which the former consists. The beginning of this stage is represented in Spee's ova shown in Figs. 18 and 19. The general relations of the various parts of the blastocyst are here the same as in the ova of Bryce-Teacher and Peters, but two points of progress are apparent. Firstly, the outer envelope is beset with branching processes or villi, consisting of an outer epiblastic covering, and an inner mesoblastic core of connective tissue which soon becomes highly vascularised. Secondly, the embryonic area with its amniotic and entodermic vesicles is connected with the outer envelope by a mesoblastic process which is the precursor of the umbilical cord ; it is known as the *abdominal pedicle* or *ventral stalk*, since it comes, at a later stage, to be attached to the ventral surface of the body of the embryo.

The relatively small size of the amnion is well shown, and it will be observed that the arrangement closely resembles the diagrammatic representation of the development of the amnion shown in Fig. 8. Plate II represents an ovum of three weeks' development which has been described by Waterston. It follows closely upon that of Graf Spee, and is clearly more advanced than that of Peters, for villi are

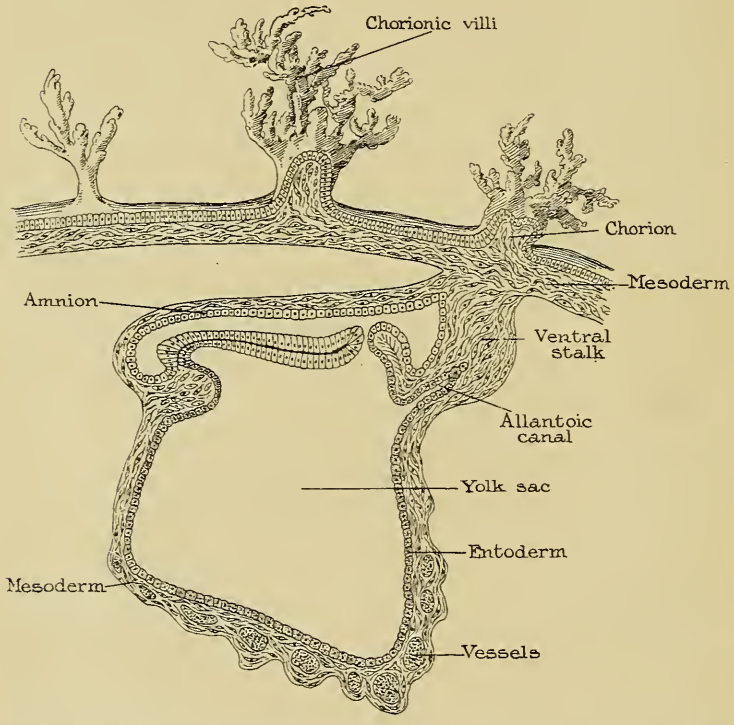


Fig. 19.—Sagittal Section of Spee's Ovum; a little more advanced than Fig. 18. (Graf Spee.)

well developed in it. The preponderating size of the chorionic vesicle is well seen; the small size and incomplete formation of the amnion, and the large size of the yolk sac are points which are better seen in this ovum than in any other which we possess. It will be seen also that vessels are present in the body of the embryo and the yolk sac; the chorionic membrane and villi are not vascularised, but

PLATE II.

A Three Weeks Human Ovum found embedded in a Decidual Cast (Waterston).

the ventral stalk contains vessels which will shortly reach the chorion and supply it.

The relations of the chorion to the decidua must now receive attention, and it will become evident that important developments have occurred in the relation of the embryonic and maternal structures to one another.

These relations can best be seen, however, in another

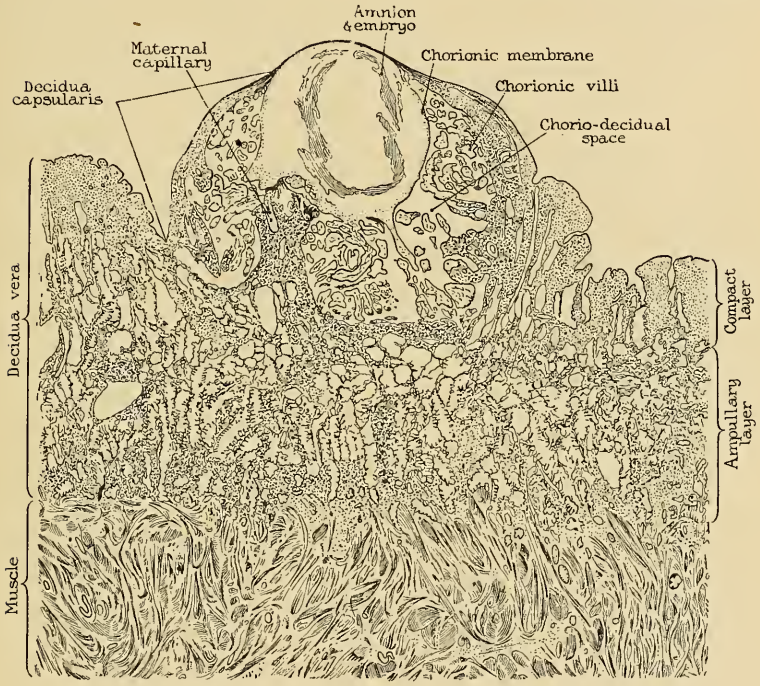


Fig. 20.—Leopold's Ovum *in situ*. (Leopold.)

ovum of a somewhat later period—that of Leopold, shown in Fig. 20. This ovum, which was examined *in situ*, was at first estimated to belong to the end of the first week of development; it is, however, in all probability very considerably older than this, and is estimated by Teacher at about seventeen to eighteen days. The manner in which the relations of the ovum to the decidua are developed has been shown diagrammatically in Fig. 12.

In Leopold's ovum it is apparent that the decidua and the

chorion are separated by a considerable space except at the two poles; at the base a process of the decidua basalis directly supports it; at the free pole chorion and decidua are united over quite a considerable area, corresponding to the position of the fibrin cap in Peters's ovum. The space between chorion and decidua is termed the *chorio-decidual space*, and is occupied by numerous villi, seen in section in the figure, most of which contain blood-vessels. Some are free, some are attached to the decidua by their tips; in the spaces between them lies fresh maternal blood, and one or two delicate maternal capillaries can be seen opening into the chorio-decidual space. The chorio-decidual space represents the area over which decidual tissue has been destroyed by the agency of the trophoblast; the chorionic villi have replaced the irregular network of plasmodial processes and cellular columns which constituted the trophoblast; and further the villi have become vascularised by the ingrowth of blood-vessels from the growing embryo. This is obviously a great advance towards the formation of a placenta with a double, *i.e.* fœtal and maternal, circulation. In a second, somewhat older ovum, Leopold found that the whole surface of the chorion was beset with villi, the chorio-decidual space being continuous around the entire ovum. Even if there is no definite maternal circulation through the chorio-decidual space, the villi are certainly vascularised, and nutritive materials from the effused maternal blood can be taken up by osmosis into the fœtal circulation. The arrangement corresponds, in fact, to a simple form of diffused placenta surrounding the whole ovum, and shows a distinct advance in construction upon the trophoblast previously described. In this manner the nutrition of the ovum is carried on, while time is gained for the formation and growth of the highly complex discoidal placenta. It is not until the end of the sixth week that this placenta begins definitely to be formed, so that the chorio-decidual space plays an important part in the nutrition of the ovum for a considerable period, from the third to the sixth week.

The structure of the chorion during the first six weeks of development must now be more fully described. The chorion at this period is everywhere covered with complex branching villi. In their earliest form the villi are short,

thick columns which subdivide in a digitate manner (Fig. 19). Later on they become complex, arborescent structures, the main divisions of which contain large vessels ; only the terminal and sub-terminal branches are then called villi. These however constitute the great bulk of the developed chorion and are definitely arranged in clusters in an ovum of about six weeks' development (Fig. 21), and form a thick layer of

FIG. 21.—Complete Ovum 3·5 cm. × 4·25 cm., about the sixth week of development. The chorion is beset with villi which are arranged in clusters. The dark area in the upper part is blood-clot. (Charing Cross Hospital Museum.)

delicate branching processes springing from the outer surface of the chorion, which in places can be seen as a smooth membrane. The chorion consists of three main elements : (1) an epithelial covering ; (2) a connective-tissue stroma ; (3) a system of blood-vessels.

(1) The chorionic epithelium is the outer covering. It consists of two distinct layers—an *outer* layer of multinucleated protoplasm, undifferentiated into cells ; and an

inner layer of large well-defined cells with oval nuclei, frequently resting upon a distinct basement membrane (Fig. 23). These layers are respectively derived from the plasmodi-trophoblast and cyto-trophoblast previously described in connection with the imbedding of the blastocyst. The outer layer is termed the *syncytium*, or simply the

FIG. 22.—Villi from a six weeks' ovum, showing the proliferation of the syncytium (low power).

plasmodial layer ; the latter is termed the *cellular layer*, or, after its discoverer, the *layer of Langhans*. Both layers are of ectodermal or epiblastic origin, although for a long time it was thought that the outer layer was derived from the decidua and was therefore maternal. During the first two months of development the chorionic epithelium displays great proliferative activity, both layers partici-

pating, but especially the syncytium. The latter structure throws out enormous numbers of plasmodial buds and processes in the form of knobs, club-shaped outgrowths, or slender elongated bands ; in a microscopic section many of these buds are seen cut across in transverse section and appear as independent areas or islets of nucleated plasmodium (Fig. 22). In earlier descriptions of the placenta they were described as ' giant cells.' The cells of the deep layer also proliferate actively, especially at the sides and

Fig. 23.—Edge of a Villus from the same specimen as Fig. 22, showing the double layer of cells of which the epithelium consists (high power).

tips of the villi ; they appear as clusters of cells usually covered with a thin layer of plasmodium. These also may be seen cut across in transverse section, and are distinguished as the ' islets of Langhans ' ; at one time they were regarded as decidual in origin. A characteristic feature of the young syncytium is extensive vacuolation ; it will be recollected that this point is also to be observed in the trophoblast. At first numbers of minute spaces are formed in the protoplasm, which increase in size by fusion, and ultimately form large spaces. In this way syncytial buds become

excavated so that the subjacent mesoblast is able to grow out into them, carrying with it blood-vessels, and thus the bud is converted into a new villus.

The syncytium contains a large amount of glycogen and finely divided fat, the function of which is not clearly understood. It has been already mentioned that the trophoblast

Fig. 24.—Fully formed Villus from a Placenta at term, showing wide capillaries. It will be noted also that the epithelial covering is atrophied and incomplete.

exerts a destructive (necrotic) action on the maternal tissues with which it comes in contact, and that this effect is often plainly seen in the case of maternal vessels into which syncytial buds have penetrated after eroding the walls. This action can be observed also in the young placenta where chorionic and maternal tissues come in contact with one another. An interesting result often ensues, viz. small buds

and processes of syncytium become broken off and carried by the blood-stream into distant parts, where they are arrested as emboli in capillary vessels. More rarely a complete villus may thus form an embolus in the lung or some other organ. In morbid conditions of pregnancy this passage of fragments of chorionic tissue, chiefly epithelial, into the maternal blood-stream is much more abundant than in normal pregnancy, and this subject will be referred to again in connection with eclampsia.

(2) The stroma is a delicate reticulum of connective tissue, embryonic in type, which supports the blood-vessels ; in the larger chorionic branches it is more compact than in the terminal branches or villi. The interstices form a system of anastomosing channels which are probably of the nature of lymphatics.

(3) The blood-vessels are the terminal ramifications of the umbilical arteries and veins ; in the larger chorionic branches they lie in the axis ; in the terminal villi capillaries only are found, and these lie immediately beneath the epithelium, where they run a tortuous course and anastomose freely. In an injected placenta, a tiny thread of colouring-matter can often be traced from a villus into one of its syncytial buds, showing the commencement of vascularisation. The fully developed villi are extremely vascular, and often appear under the microscope to be as full of blood as a soaked sponge (see Fig. 24) ; between the fœtal blood in the villi and the maternal blood in the chorio-decidual space nothing intervenes except the chorionic epithelium and the endothelium of the fœtal capillary wall.

The chorion retains the characters just described until the second half of the period of gestation, when changes in its structure occur which will be referred to later on. The chorio-decidual relations undergo no marked change until the latter half of the second month, when the formation of the discoidal placenta is begun. The process simply consists in the specialisation of a part of the chorion to perform the work previously done by the whole. As the placenta develops the villi covering the general surface of the chorion become devascularised and undergo atrophy early in the third month. At the placental site—the base of the ovum, the villi increase greatly in size, number, and complexity, while important

changes also occur in the underlying decidua. A diminution in the total area of the villous chorion is thus compensated by the specialisation of a part of it.

The changes which now occur at the placental site lead up to three important results: (1) by repeated subdivision

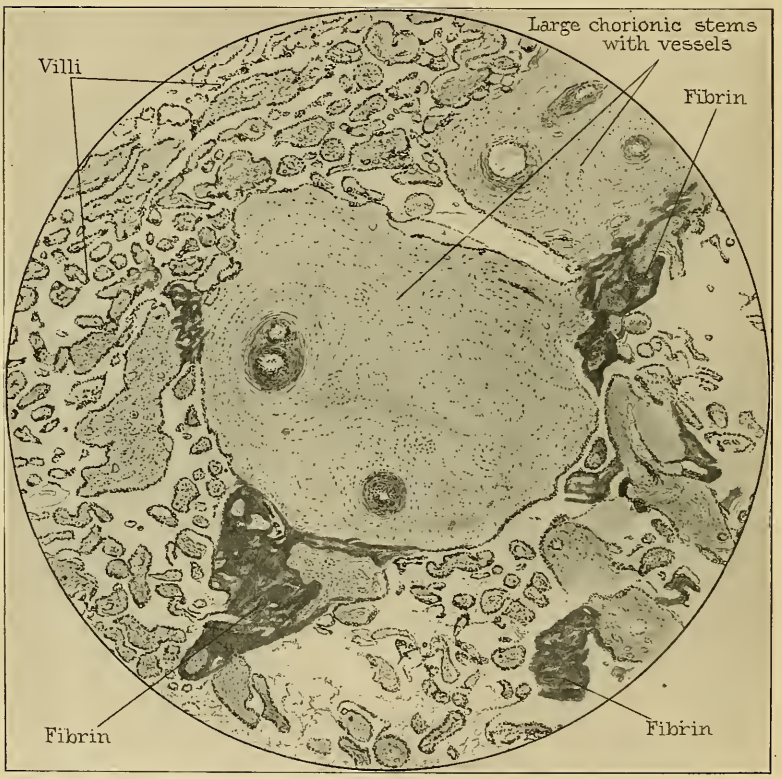


FIG. 25.—Fully developed Placenta of the eighth month. In the larger stem is an artery, in section, with the lumen narrowed by endarteritis.

enormous numbers of chorionic stems and terminal divisions (villi) are produced; (2) firm attachments are formed between the fœtal and maternal elements; (3) a definite maternal circulation is established through that portion of the chorio-decidual space which is in relation to the decidua basalis.

(1) The *enormous numbers of villi* present in the placenta will be understood from an examination of Fig. 27, which

represents a vertical section through the entire placenta. The larger chorionic stems spring from the chorionic membrane underlying the amnion, and, dividing irregularly, terminate in an indefinite number of small divisions termed villi. Some of these stems traverse the whole thickness of the placenta, so that their terminal villi

FIG. 26.—Placental Villus attached to the Decidua. The proliferating cells of Langhans' layer have invaded the decidual tissues.

reach the decidua basalis. Both villi and larger branches appear in sections to be of diverse size and shape (Fig. 25), but this is partly due to the varying angles at which they have been cut. The larger branches all contain large vessels, and through the centre of the largest of all one or more arteries and veins, running side by side, can usually be traced. The villi are not in contact with one another, but are separated by spaces—the intervillous spaces. It will be

obvious that these spaces form throughout the placenta an elaborate system of branching channels allowing free com-

FIG. 27.—Section through a Seven Months' Placenta *in situ*. (Minot.)

munication to take place between one part of the organ and another. Through the general system of intervillous spaces the maternal circulation is carried on, so that a gentle stream

of maternal blood is perpetually flowing around the villi. When the large numbers of these villi are borne in mind, it will be evident that the superficial area of contact between the fœtal structures and the maternal blood in the placenta is of very great extent. In many places adjacent villi become united to one another by small deposits of fibrin; isolated syncytial masses are seen here and there, and in places clusters of nuclei, representing areas of proliferating Langhans' cells, can be seen on the surface of a villus or free in the intervillous spaces (islets of Langhans). A good deal of maternal blood can be found in the intervillous spaces

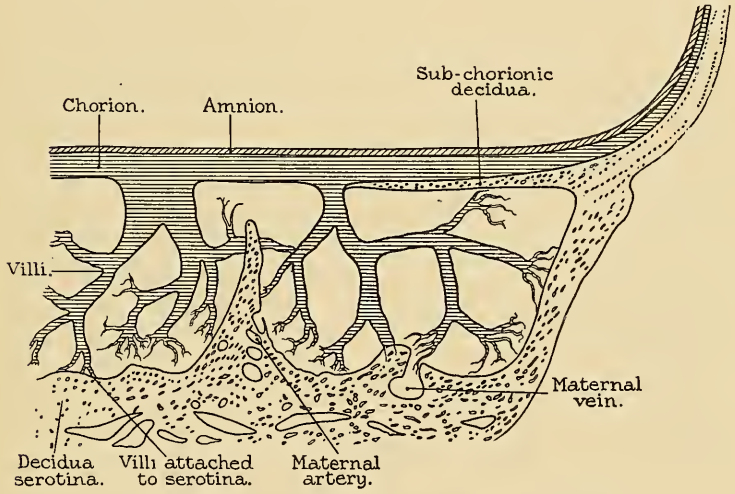


FIG. 28.—Scheme of the Placental Attachments.

when care is taken to prevent it from escaping during the preparation of the tissue for microscopic section.

(2) The *placental attachments* consist of (*a*) a firm union between large numbers of villi and the surface of the decidua basalis, and (*b*) a special development of the decidua at the margins of the organ. (*a*) The attachment of the villi to the decidua presents some interesting features. Where the two come into contact, the syncytial layer of the chorionic epithelium disappears, and a marked proliferation of the cells of Langhans occurs; these cells spread out over the adjacent surface of the decidua for some distance, and also penetrate it to some extent, lying among the decidual

cells proper (Fig. 26). In this way the villus and the decidua become firmly welded together by a vital process of growth. Many villi can be found deeply imbedded in this manner; others are attached merely by their tips. (*b*) At the placental margin where the three parts of the decidua are united, the membrane is of great thickness and strength; from this thickened portion a process can be traced running inwards for a distance of 1 to 2 inches beneath the chorionic membrane (Fig. 28), thus adding greatly to the area and strength of the union between maternal and fœtal structures. This portion is termed the *sub-chorionic decidua;* it will be seen that it limits circumferentially the general system of the intervillous spaces.

(3) *The development of the maternal circulation* through the placenta has not yet been traced in detail; great controversy has raged in the past upon the origin of the intervillous spaces, into which we need not enter, as this controversy is now dead. The ova of Peters and Leopold show us the beginnings of these spaces, and no great stretch of the imagination is required to carry the student from the reticulated trophoblast of the second week to the chorio-decidual space of the third, and from the latter to the intervillous spaces of the placenta itself. The intervillous spaces are, of course, progressively developed from the meshes of the trophoblast. In an ovum of two weeks' development small mesoblastic processes may be seen penetrating the trophoblast buds for a short distance. Later on these buds may be seen to have increased greatly in length; later still they become branched, and are then vascularised by vessels which grow into them from the chorion. These are fully formed chorionic villi; they are separated from one another by a system of inter-communicating spaces which are the direct derivatives of the meshes of the trophoblast. During the development and growth of the placenta large maternal vessels become laid open, so as to communicate with these spaces, and the active agents in the production of this important change are the chorionic villi. The destructive influence exerted upon maternal tissues by the young chorionic epithelium has been referred to; evidences of penetration of the walls of maternal vessels by syncytial buds and processes are abundant in the developing placenta, where all stages

of the process may be traced in tissue cut into serial sections. The vessels thus penetrated are probably merely the dilated capillaries or 'sinuses,' which have been described as occurring in the endometrium of menstruation and in the decidua—*i.e.* they are vessels the walls of which consist merely of an endothelial coat, and which therefore offer but a feeble resistance to the proteolytic action of the chorionic epithelium. After having been thus laid open they lose their endothelial lining. It is often difficult to distinguish afferent from efferent maternal channels, since both arise from dilated capillaries. A minor result of proteolytic action is that the surface of the decidua basalis becomes irregularly excavated and presents a series of elevations and depressions. Where villi are not in actual contact with the decidua a thick layer of fibrin is deposited upon it from the maternal blood. Many maternal vessels can be seen opening into the intervillous spaces on the floor of the decidua (Fig. 27). The maternal circulation through the placenta is probably slow. The coiling course of the uterine arteries in the muscular coat diminishes the force of the current entering the placenta ; the outflow from the intervillous spaces is perhaps aided by the intermittent uterine contractions characteristic of pregnancy, which may have the effect of aspirating the blood into the veins. Towards the middle of pregnancy the sub-placental sinuses assume very large proportions, and their closure after the placenta has been shed is a matter of vital importance to the life of the mother.

Concurrently with the formation of the placenta, the villi of the extra-placental chorion atrophy and become functionless, converting that portion into a smooth membrane to which the name *chorion læve* is applied ; the placental chorion is termed the *chorion frondosum*. Chorion læve and decidua capsularis are not united by intergrowth, as are chorion frondosum and decidua basalis.

As these changes progress the chorio-decidual space outside the placental area becomes obliterated by the pressure of the growing ovum ; atrophied villi surrounded by deposits of fibrin may always be found in the membranes at term if looked for under a microscope (Fig. 29). The placental area grows very rapidly during the first few weeks of its

formation, until at the end of the third month, when the ovum fills the uterine cavity, it occupies about one-fourth to one-fifth of the total area of the surface of the uterine walls. Afterwards it grows *pari passu* with the uterus, and the same proportion is preserved up to term.

When the ovum grows large enough to fill the uterine

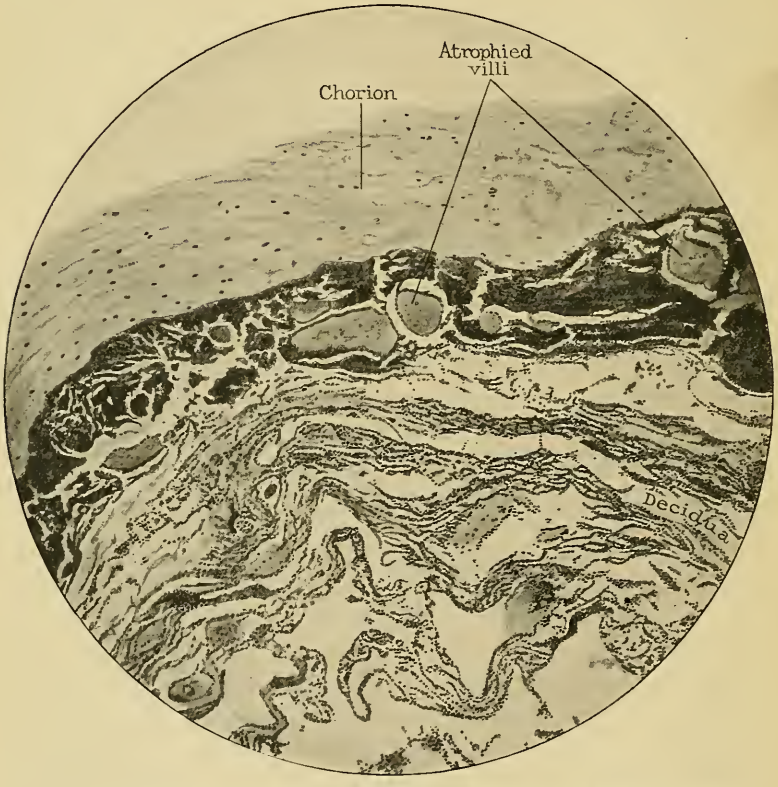


FIG. 29.—Section through the Membranes near the placental margin. The atrophied villi show remains of their epithelial covering.

cavity completely—*i.e.* about the end of the third month —the decidua capsularis becomes apposed to the decidua vera, and at term these two portions of the maternal membranes are inseparable. Up to the end of the third month a space exists in the uterine cavity below the ovum, bounded above by the decidua capsularis, laterally by the decidua vera, and below by the os internum ; it is called the *decidual*

space (Figs. 14 and 15). When the two portions of the decidua become apposed, the decidual space is obliterated. At term the decidua capsularis has undergone extensive atrophy from pressure, and the same change, but less advanced, is observed in the decidua vera. This is of importance in relation to the process of shedding the placenta.

Upon the maintenance of the relations just described between the fœtal and maternal elements of the placenta the nutrition of the fœtus *in utero* entirely depends. After the formation of the firm chorio-decidual attachments, accidental separation of the two is not so readily brought about as at earlier periods ; hence the diminished liability to abortion after the third month.

We know very little about the details of the interchanges between the fœtal and maternal blood-currents. Particles of finely divided insoluble solid matter artificially introduced into the maternal circulation in animals, cannot pass through the placenta to the fœtus ; but micro-organisms are able to do so in disease. It has been shown by Küss that the following bacteria may be transmitted from mother to fœtus through the placenta : tubercle bacillus, bacillus of anthrax, diphtheria and glanders, the pneumococcus, streptococcus, and meningococcus. Further, it has been shown by experiment that the placenta possesses a certain selective power in transmission, for chemical substances in solution are not all transmitted, and those which pass the placenta do so at unequal rates. Further, the selective action of the placenta is modified when maternal disease is present. From comparative analyses of the fœtal blood flowing to and leaving the placenta, we know that it gives up carbonic acid and absorbs oxygen in transit. The placenta is therefore the respiratory organ of the fœtus, but we know little or nothing of the other nutritional interchanges effected by the placental circulation. Osmosis can, of course, readily take place between the fœtal blood in the vessels of the villi and the maternal blood in the intervillous spaces, and it is easy to understand how soluble solid and gaseous substances can pass freely from mother to fœtus, or the reverse. Glycogen and fat are present in the placenta in considerable amount, but whether these substances are derived directly from maternal sources, or whether they are produced by the fœtal

liver or other fœtal organs and deposited in the placenta from the fœtal blood, is at present unknown.

The presence of a proteolytic ferment and of other enzymes in the fœtal portion of the placenta has been demonstrated by physiological experiment, but nothing is definitely known of their origin or of their functions in regard to fœtal metabolism.

The Placenta at Term.—When shed from its uterine attachments the placenta is an oval or circular flat cake or disc measuring 6 to 8 inches (15 to 20 cm.) in diameter, $\frac{3}{4}$ to 1 inch (2 to $2\frac{1}{2}$ cm.) in depth at the centre, which is the thickest part, and weighing about sixteen ounces. The margin is thinner and firmer than the centre, and passes abruptly into the chorion læve. The *fœtal surface* is covered with a thin smooth membrane—the amnion, which can be readily stripped up to the insertion of the umbilical cord. The surface of the chorion thus exposed is also smooth in appearance, and running over it are seen the large superficial branches of the umbilical vessels. The arteries run irregularly outwards, but never quite reach the margin in a normal placenta (Fig. 30) ; the veins accompany and often cross them. If the fœtal surface is now incised, the chorionic membrane is seen to be about one line in thickness, and from its deep surface springs the mass of spongy tissue representing the villi. The *uterine surface* (Fig. 31) contrasts strongly with this. It is of a dull red colour, and is divided by sulci into a number of irregularly quadrilateral areas termed the cotyledons. No vessels are visible upon it. On close inspection it can be seen to be covered with a thin greyish mottled membrane which represents the shed portion of the decidua basalis ; in parts this is incomplete, exposing the deep red spongy tissue beneath, and often it feels gritty to the touch from the presence of minute areas of calcareous degeneration. In some instances, areas of calcareous degeneration are found large enough to be visible to the naked eye ; these are generally found near the centre of the placenta. Around the margin runs a large venous channel called the *circular sinus*, which returns some of the maternal blood from the intervillous spaces ; it seldom completely surrounds the placenta. If the placenta is incised, a great deal of dark blood slowly runs away from it,

and if a stream of water is turned upon the cut surface the intervillous spaces will be washed out and the arborescent villi appear as a dense reticulum of greyish threads. The

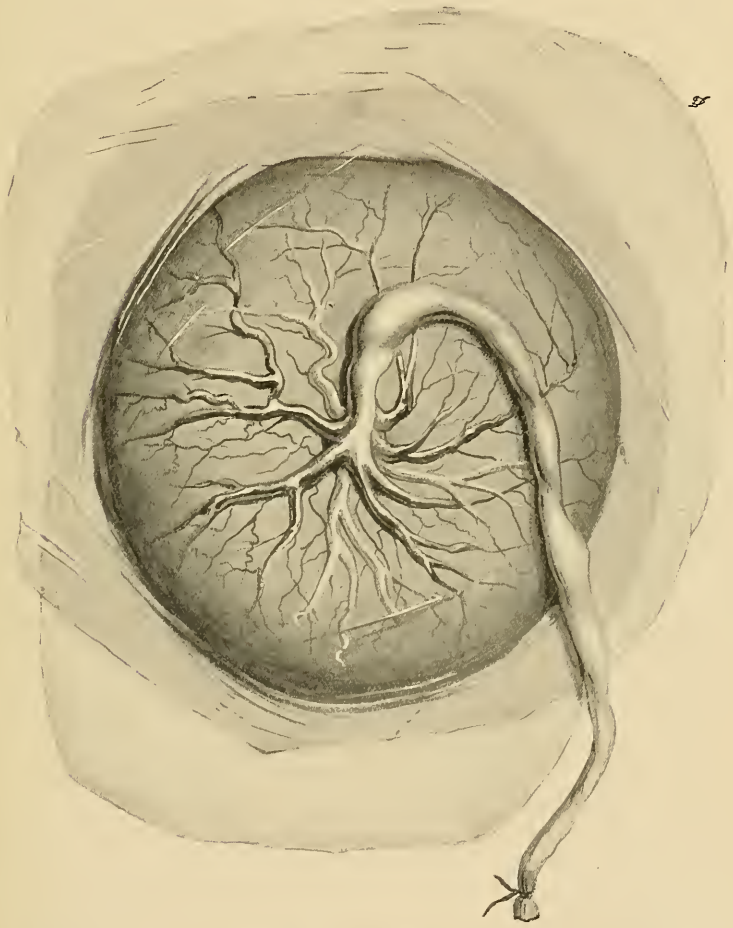


Fig. 30.—Human Placenta, fœtal surface; the inner thin membrane is the amnion, the outer thick one is the chorion.

placenta is usually attached to the upper part of the body of the uterus, including the fundus, and, with about equal frequency, to the adjacent anterior or posterior wall.

Clear evidence of extensive degeneration is to be found in the placenta at term. It must be remembered that the

placenta is a caducous structure which, after serving its temporary purpose, is cast off by the organism. Degeneration is the necessary preliminary of shedding, and merely indicates a progressive diminution of vitality towards the close of the period of its existence. These degenerative changes are chiefly of importance because of the necessity of distinguishing them from true morbid processes. Both

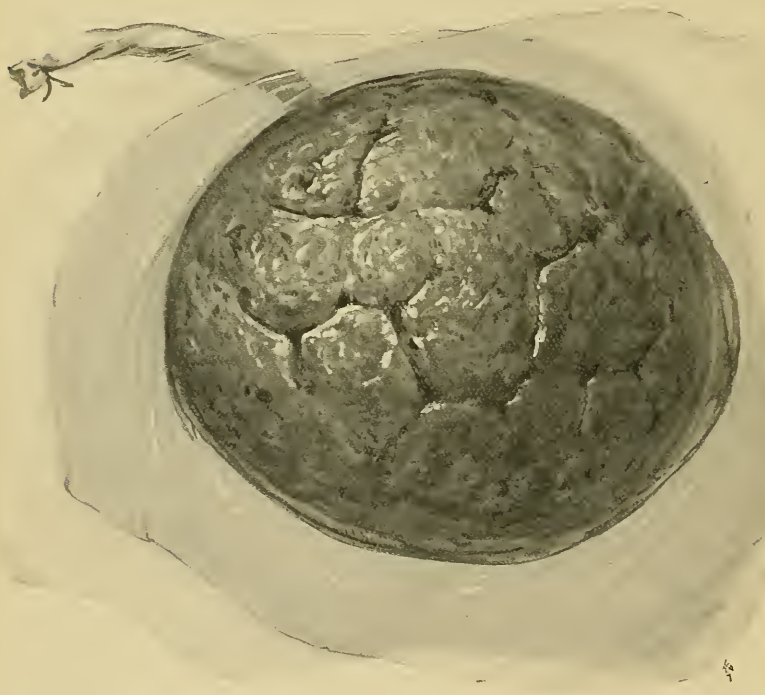


FIG. 31.—Human Placenta, uterine or maternal surface. The white patches are areas of calcareous degeneration.

the fœtal and maternal elements of the placenta are affected. The initial change consists in the occlusion of considerable tracts of the middle-sized divisions of the umbilical arteries by a process of obliterating endarteritis ; it may be found as early as the seventh month of pregnancy, and it slowly progresses. This causes a diminution in the blood supply of the villi fed by the affected arterioles, which results in their gradual atrophy and degeneration ; this again is

accompanied by the extensive deposition of fibrin from the maternal blood upon the chorionic epithelium, so that the neighbouring villi meet and the intervillous spaces of the affected area thus become obliterated. In this manner solid patches are formed among the spongy placental tissues, in which the villi are functionless, for the fœtal circulation has been arrested by obliterating endarteritis, while the maternal circulation has been destroyed by blocking of the intervillous spaces with fibrin. These patches are termed *placental infarcts ;* they occur as firm yellowish-white well-defined areas, varying in size, under normal conditions, from that of a millet seed to that of a filbert. They are most numerous on the uterine surface and on the marginal cotyledons. The superficial layers of the decidua basalis undergo a form of coagulation necrosis, and upon the necrosed areas laminated deposits of fibrin from the maternal blood are formed. In addition, extensive thrombosis occurs in the sub-placental sinuses during the later months of pregnancy, the cause of which is not well understood, but which certainly interferes to some extent with the freedom of the maternal circulation.

From about the fifth month onwards the chorionic epithelium consists of only one layer—the syncytium ; the layer of Langhans has disappeared. The syncytium is also much less active in the later than in the earlier months, throwing out comparatively few buds and processes ; and as term approaches this layer becomes atrophied and incomplete (Fig. 24).

It is possible that these degenerative changes limit the duration of pregnancy, and participate in causing the onset of labour by rendering the placenta incapable of providing for the continually increasing nutritional requirements of the fœtus.

Amnion, Umbilical Cord, and Fœtus

Amnion.—This membrane consists of an outer layer of mesoblast and an inner layer of epiblast. In the human ovum it is probably from the first a closed sac, and in the earliest ova it is seen to be very much smaller than the chorion and separated from it by a considerable thickness

of mesoblastic tissue. These relative proportions are preserved for some weeks, and so slowly does the fluid accumu-

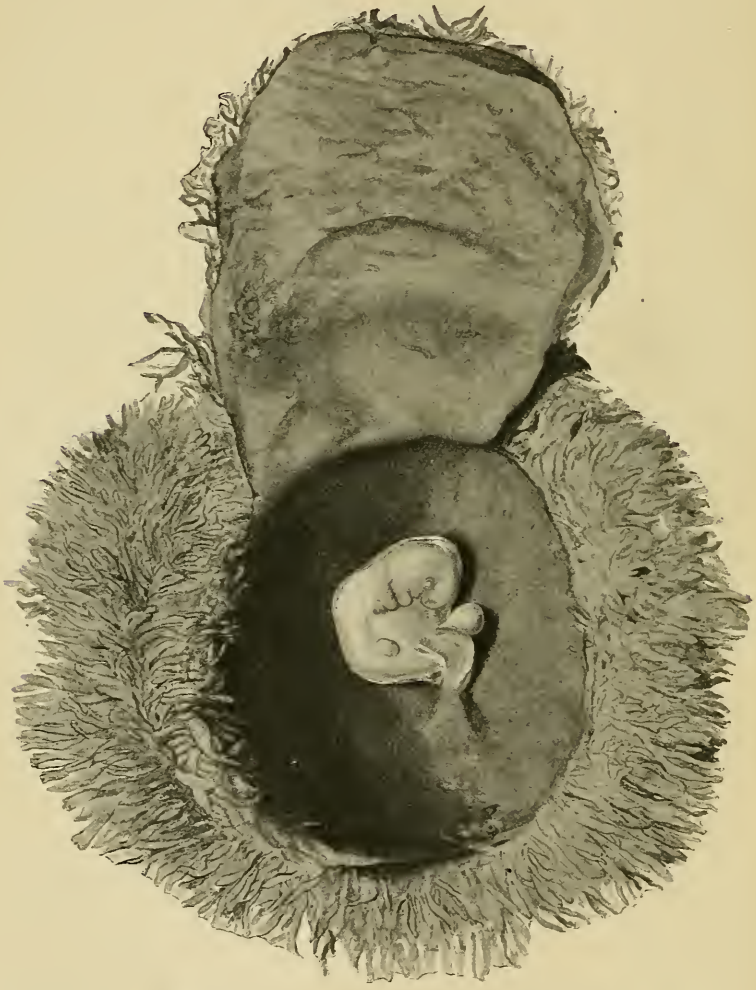


FIG. 32.—Complete Ovum from the fourth or fifth week, magnified. The fœtus is closely invested by the amnion, and is attached by the ventral stalk to the wall of the chorionic vesicle. (Quain's Anatomy.)

late in the amnion that it does not grow large enough to come into contact with the chorion until the third month (Figs. 33 and 34).

Until the body of the embryo has been clearly defined the amnion covers only its dorsal surface; gradually, however, its line of origin advances over the ventral surface to converge upon the umbilical cord. Ultimately amnion and chorion come in loose contact by their mesoblastic surfaces, but no vital union takes place between them. The fully formed amnion consists of a single layer of cubical or low columnar epithelium resting upon a stratum of loose connective tissue. As pregnancy advances the epithelium

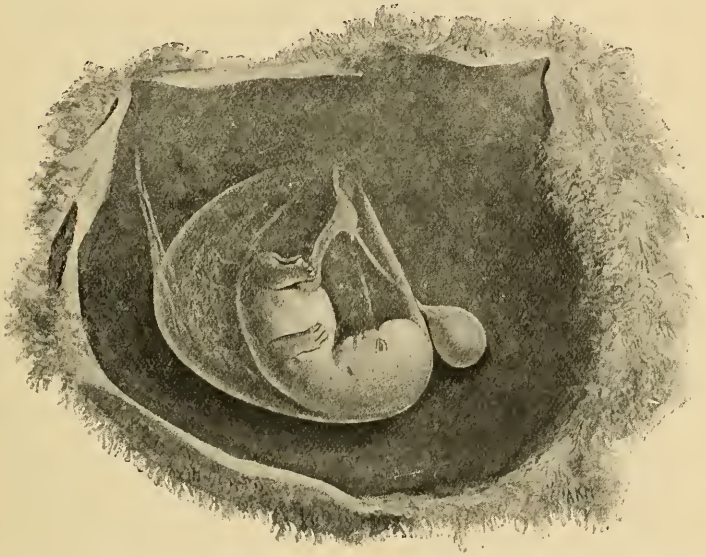


FIG. 33.—Complete Ovum from about the ninth week. Note the large size of the chorionic vesicle, and the small size of the amniotic sac, which is full of fluid. (Quain's Anatomy.)

becomes flatter. The amnion is firmly united to the umbilical cord at its point of insertion into the placenta, so that it cannot be stripped off the cord, although it is readily separable from both the placental and extra-placental chorion (*chorion frondosum* and *chorion lœve*).

At an early period fluid (the liquor amnii) appears within the amnion, separating it from the dorsal surface of the embryo. This gradually increases in quantity as development advances, until at term it amounts on an average to one or two pints; variations from ten to fifty ounces are, however,

not uncommon under normal conditions. At term it is a clear pale fluid of low specific gravity, and its composition, according to Hoppe-Seyler, is as follows :

Water	98·41 per cent.
Albumen	0·19 ,,
Inorganic salts . . .	0·59 ,,
Extractives	0·81 ,,
	100·00

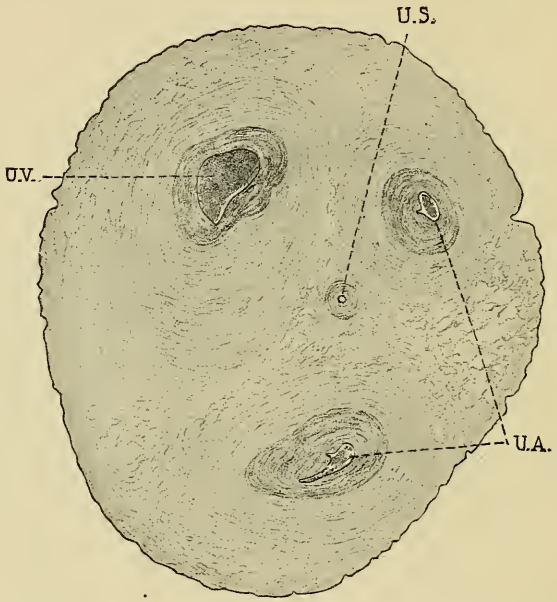


Fig. 34.—Umbilical Cord near Fœtal End, ×5½. (Whitridge Williams.)
U.A.—Umbilical Arteries. U.S.—Remnant of Allantois. U.V.—Umbilical Vein.

The amount of albumen present in the early months is much higher than this, and may reach 10 per cent. The most important extractive is *urea*, which is present in traces from the sixth week onwards. Various matters in suspension are also found, such as lanugo hairs, epidermal scales, cells derived from the amniotic epithelium, and particles of vernix caseosa detached from the skin of the fœtus. Glucose may be found in cases of maternal diabetes. The function of the amniotic fluid is mainly protective. It assists in maintaining an even temperature, acts as a buffer against external injuries, equalises pressure, allows free movements of the

fœtus, and flushes the passages from within with a sterile fluid during labour. Nutritive value has been claimed for it on the ground that it is swallowed by the fœtus during the latter months of gestation. Certainly lanugo and epidermal scales are not uncommonly found in meconium, and there is no doubt that they have entered the alimentary canal by being swallowed with liquor amnii; sometimes also balls of fine lanugo hairs have been found in the stomach of a dead fœtus. It is possible, therefore, that fluid obtained by swallowing liquor amnii may be of use in the general metabolism of the fœtus.

Umbilical Cord.—This structure connects the body of the fœtus with the placenta. Its earliest appearance in the human ovum is shown in the specimens of Spee (Figs. 18 and 19), where a band of the mesoblastic tissue is seen uniting the embryonic area, with its amnion and umbilical vesicle, to the chorion. This band was previously described by His, who termed it the *ventral stalk*. Along this stalk pass the fœtal vessels which vascularise the growing chorion; they are branches of the posterior end of the primitive abdominal aorta. Later the *allantois* also grows into it; this structure is an outgrowth from the hinder end of the primitive gut, and in lower mammals it is larger, and plays a much more important part, than in man. Sometimes in the human ovum the allantois does not extend as far as the chorion at all; and according to His the ventral stalk may be vascularised before its appearance, so that it is evident that the part which it plays in the development of the umbilical cord is a secondary one. Later on the *entodermic* or *umbilical vesicle*, with its omphalo-mesenteric (vitelline) duct, also fuses with the ventral stalk, so that the umbilical cord when fully formed

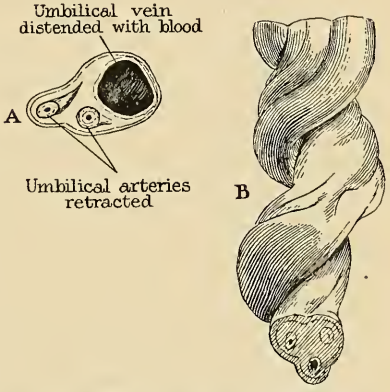


Fig. 35.—The Umbilical Cord at Term.
A. Transverse section showing vessels.
B. A portion showing torsion.

consists developmentally of the following component parts: (1) the ventral stalk; (2) the umbilical blood-vessels from the primitive aorta; (3) the allantois; (4) the umbilical vesicle with its vitelline duct.

In an early embryo (Figs. 32 and 39) the cord is short and very thick; its surface is ridged, and it is attached to the ventral surface close to the caudal extremity. About the third month of gestation four vessels are found in the cord—two arteries and two veins; the latter afterwards fuse to form a single vessel, so that at term there are two arteries and one vein. Traces of the allantois, in the form of a small canal lined by cubical epithelium, may be found in the fœtal end of the cord up to term (Fig. 34). The umbilical vesicle is seen in ova of about the second month to be of considerable size, and attached by a long pedicle to the umbilical cord near its ventral attachment. Later on it disappears, but it is stated that a trace of it may sometimes be found at term in the form of a minute yellowish body at the placental insertion of the cord. The cœlom is also prolonged into the cord, and coils of small intestine may be found at the fœtal end in the early months of gestation, and this condition may persist to term, giving rise to a congenital ventral hernia or *exomphalos*.

Fig. 36.—Umbilical Cord with True Knot. (Charing Cross Hospital Museum.)

At term, the cord varies in length from 5 to 60 inches (12 cm. to 150 cm.), the average being from 18 to 24 inches (45 cm. to 60 cm.). The vessels are always twisted, the arteries usually encircling the vein from left to right; this torsion is evident as early as the third month, but the cause of it is unknown (Fig. 41). The substance of the cord is composed of a special form of embryonic connective tissue,

which has been called Wharton's Jelly. It consists of small stellate cells with long processes; anastomosing with others, the processes form a wide network, the meshes of which are

FIG. 37.—Wharton's Jelly, showing the Stellate Cells. (Galabin and Blacker.)

filled with gelatinous material (Fig. 37). This connective tissue is irregularly disposed round the vessels, giving rise, in places, to protuberances termed *false knots*, which at times, but not always, contain a loop of vessels. Sometimes a

FIG. 38.—Epithelium of Umbilical Cord. (Whitridge Williams.)

true knot is formed by the fœtus slipping through a loop of a very long cord *in utero* (Fig. 36). This does not necessarily arrest the circulation through the cord. The epithelial covering of the cord consists at term of stratified cubical cells, resembling the fœtal epidermis (Fig. 38). It is

generally believed that these cells are formed from a prolongation of the fœtal skin over the umbilical cord and are not developed from the amnion.

The cord is usually attached to the centre of the placenta (*central insertion*) ; it may, however, be placed nearer the margin than the centre (*excentric insertion*) or upon the edge (*battledore insertion*), or it may be inserted upon the membranes outside the placenta (*velamentous insertion*) (see Fig. 71). The fœtal insertion of the cord is not subject to

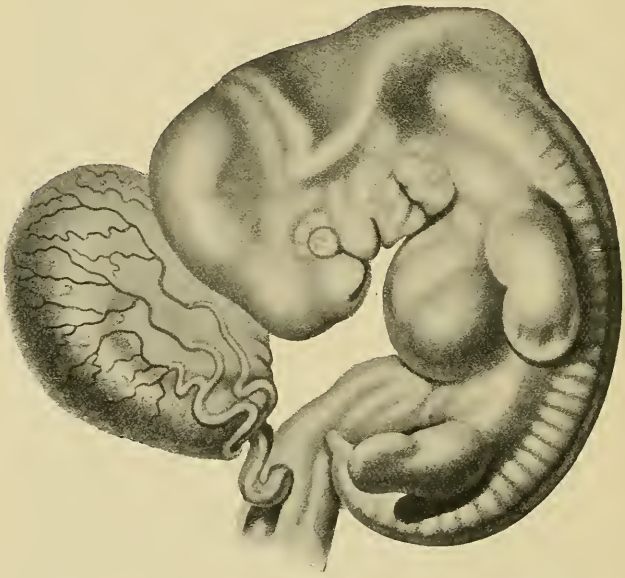


Fig. 39.—Embryo 9·1 mm. in length, of thirty-one to thirty-four days' development. (His, from Quain's Anatomy.)

variation. It will be noted that while its precursor, the ventral stalk, is attached to the caudal extremity, as the cœlom closes and the umbilical vesicle atrophies, the point of attachment is carried forward until at the fourth month it reaches the centre of the body of the fœtus.

Fœtus.—During the first six weeks of its development the human embryo is indistinguishable, except by an expert embryologist, from that of other mammals. About the end of the second month it acquires definite characteristics which serve to distinguish it from others. It is usual to speak of the

embryo during the first two months, and the *fœtus* later than that period.

In the earliest human ovum which has been carefully described, viz., that of Bryce and Teacher (Fig. 10), the embryo is represented by two minute vesicles, amniotic and entodermic, and a thickened layer of epiblast, the embryonic epiblast. Not until the end of the fourth week has been reached is the body of the embryo at all clearly defined, and at this stage it measures from 7 to 10 mm. in length (Fig. 39). It is markedly flexed, and the head is nearly as large as the remainder of the body; the branchial arches are unclosed, the limbs appear as buds, there is a large umbilical vesicle, the umbilical cord is inserted close to the caudal extremity, which is long and pointed, and there is nothing to distinguish it from the embryo of other mammals, such as the rabbit.

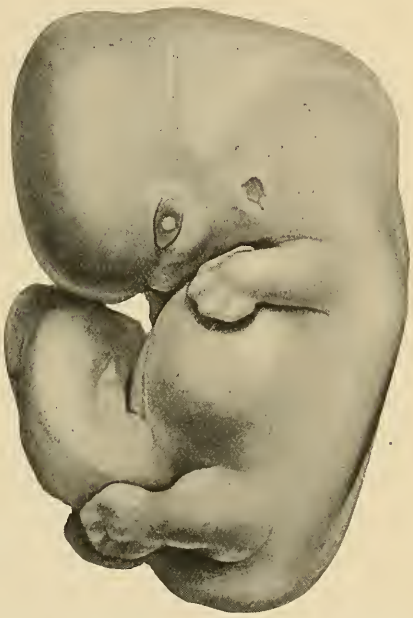


FIG. 40.—Embryo 15·5′ mm. in length, of about five to six weeks' development. (Bryce, from Quain's Anatomy.)

During the second month distinctively human features are developed, and by the eighth or ninth week it measures about 30 mm., and is not so markedly flexed (Fig. 41). The face has become closed in by the growth of the maxillary and mandibular processes, and the eyes and ears have assumed their characteristic form; the limbs have become divided into their segments and the digits are well formed. The caudal extremity or tail has become reduced to a minute tubercle.

At the end of the third month the fœtus measures 7·5 to

9 cm. (3–3½ inches) ; the umbilical cord equals it in length, and its vessels have become twisted ; although the external sexual organs are undifferentiated, the sex may be established by examination of the internal organs.

During the fourth month the muscles become developed and spontaneous movements are made.

The progress of the fœtus in length and weight during the

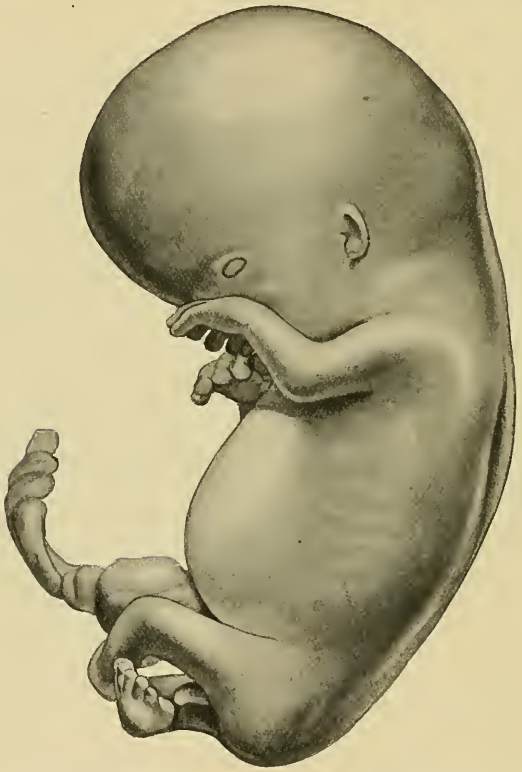


Fig. 41.—Embryo 30 mm. in length, of about nine weeks' development. (Bryce, from Quain's Anatomy.)

succeeding months of gestation is as shown in the table opposite. It will be seen that the rate of growth of the fœtus is not only very irregular from one month to another, but subject to considerable variations. A simple method of determining the period of development of the fœtus with sufficient accuracy for clinical purposes during the second five months is found by multiplying the number of the month

by five. Thus the length at the end of the seventh month 7 × 5 = 35 cm. (14 inches).

Period.	Length.	Weight.
4th month (lunar) .	10 to 17 cm. (4 to 6½ in.)	¼ lb.
5th ,, ,, .	18 to 27 ,, (7 to 10½ ,,)	½ ,,
6th ,, ,, .	28 to 34 ,, (11 to 13½ ,,)	1½ ,,
7th ,, ,, .	35 to 38 ,, (14 to 15 ,,)	2½ ,,
8th , ,, .	39 to 41 ,, (15½ to 16½ ,,)	3½ ,,
9th ,, ,, .	42 to 44 ,, (17 to 17½ ,,)	4¼ ,,
10th ,, ,, .	50 to 53 ,, (20 to 21 ,,)	7 to 7½ ,,

At the end of the seventh lunar month (28th week) the fœtus becomes capable of surviving when born—*i.e.* it becomes *viable ;* its chances of survival at this period are, however, very small. A twenty-eight weeks' fœtus has the skin of a deep, dull red colour, there is hair on the scalp, and a little sebaceous secretion has been produced. In the male the testicles have descended into the scrotum.

At the thirty-sixth week the fœtus has increased greatly in bulk, but not so markedly in length. The colour of the skin is a brighter pink and light delicate hair (lanugo) covers the whole of the body except the scalp, where long dark hair is seen. The general surface of the body is covered with a deposit of sebaceous matter (*vernix caseosa*), and a well defined layer of subcutaneous fat has appeared, giving rotundity to the outlines of the trunk and limbs. The abdomen is still relatively protuberant, especially in the upper part.

During the last four weeks the chief change is a great gain in length and weight and increase in potential activity. The free and energetic movements which the fœtus makes habitually during this period no doubt contribute to its muscular development.

The Mature Fœtus.—Though subject to considerable variations, the average length of the fœtus at term is about 50 cm. (20 inches) and the average weight 7 to 7½ pounds. Males are usually rather heavier than females. Weight is much more variable than length, for from various causes a mature fœtus may weigh much less than the average, while, from disease, a premature fœtus may equal it in weight.

Healthy mature infants may weigh only 5 to 5½ pounds, but any weight below this is probably to be attributed to pre-maturity, to hereditary syphilitic taint, or other maternal disorder. A fœtus weighing over 10 pounds is not rare; a weight of over 12 pounds is, however, very uncommon and is usually accounted for by post-maturity—*i.e.* undue prolongation of the period of gestation. The general differences between a premature and a mature fœtus may be tabulated as follows:

Seven months' Fœtus.	*Mature Fœtus.*
1. Skin lax, wrinkled, dull red in colour, little vernix caseosa.	Skin smooth, plump, pink, covered with vernix caseosa.
2. Subcutaneous fat scanty.	Subcutaneous fat abundant.
3. Hair on scalp short.	Abundant dark hair on scalp, 1 to 1¼ inch long.
4. Lanugo present over whole body.	Lanugo absent from most situations.
5. Short nails on fingers and toes.	Nails project beyond finger tips.
6. Skull sutures open.	Skull sutures closed (*i.e.* bones in contact) except at fontanelles.
7. Moves and cries feebly when born.	Moves and cries vigorously when born.

The Fœtal Circulation.—The umbilical vein, which brings purified arterial blood from the placenta, enters the trunk at the umbilicus and runs beneath the anterior abdominal wall to reach the lower surface of the liver (Fig. 42, *vu.*). Here it gives off branches to the left lobe, the lobus quadratus and lobus Spigelii, which thus receive a direct supply of pure blood from the placenta. It then gives off another branch which joins the portal vein (*vp.*) as the latter is about to enter the right lobe; as the portal vein brings impure blood from the alimentary canal, the blood-supply of the right lobe of the liver is less pure than that of the other lobes. After giving off these branches to the liver, the umbilical vein, now reduced in size and called the *ductos venosus* (*dv.*),enters the inferior vena cava (*vci.*). Blood which has passed through the liver is carried by the hepatic veins (*vh.*) to the same great venous trunk, which now contains a mixed stream consisting of pure blood from the ductus venosus, and impure blood coming up from the lower extremities through the iliac veins, and from the liver through the hepatic veins. The blood brought up to the heart by the inferior vena cava

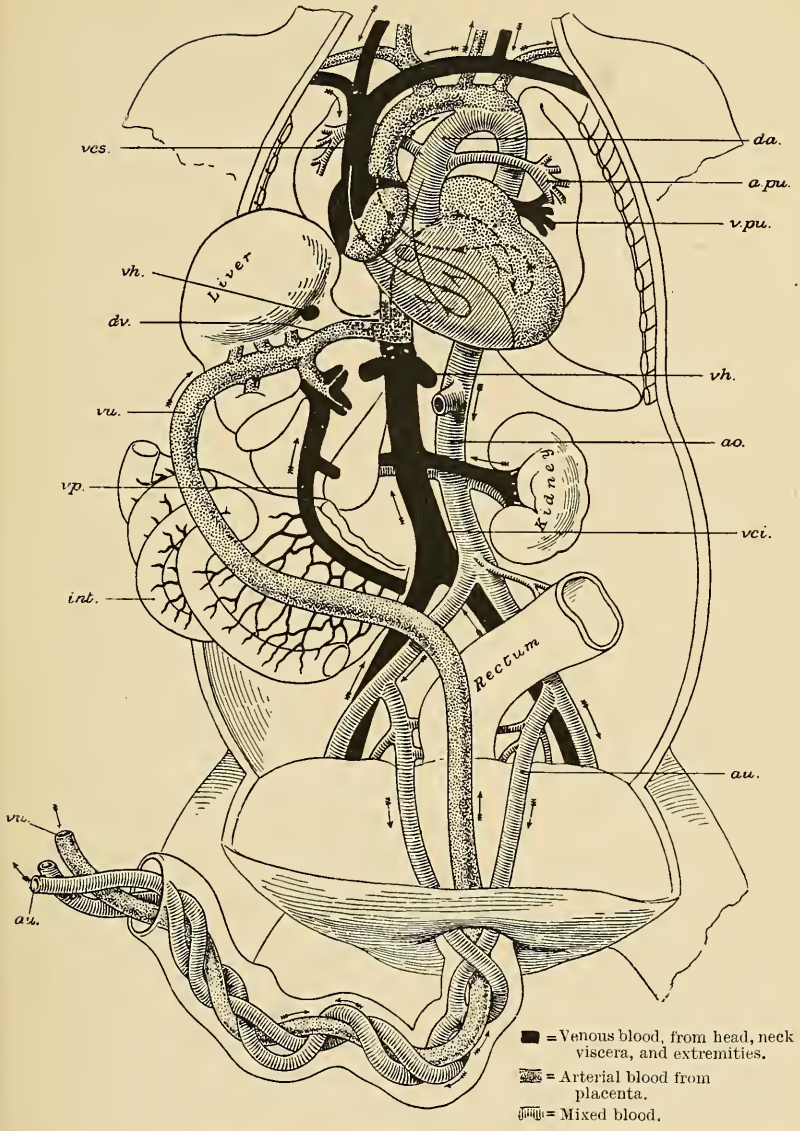


FIG. 42.—Scheme of the Fœtal Circulation. (Edgar.)

is, however, still, comparatively speaking, pure, for the amount of impure blood carried into this vessel by the hepatic and iliac veins (lower extremities and pelvis) is relatively small.

The inferior vena cava enters the floor of the right auricle, and the blood-stream is immediately directed by the *Eustachian valve* through the *foramen ovale* into the left auricle ; thence it flows through the mitral valve into the left ventricle, and thence into the aorta. From the aorta branches pass to the head, neck, and upper extremities through the innominate, left carotid, and left subclavian trunks ; excepting the liver, these parts therefore receive the purest supply of blood. From these parts the venous blood is returned to the right auricle by the superior vena cava (*vcs.*) ; thence it passes through the tricuspid valve to the right ventricle. There are therefore two blood-currents crossing one another in the right auricle, and it is believed that they are completely separated from one another by the Eustachian valve. From the right ventricle the blood passes into the pulmonary artery, which, after giving off branches to the lungs, passes on, as the *ductus arteriosus* (*da.*), to join the thoracic aorta near the origin of the left subclavian artery. The abdominal aorta (*ao.*) now contains a very mixed supply of blood consisting of a small amount of arterial blood from the placenta, which has passed from the right auricle through the Eustachian valve to the left side of the heart, and a large amount of venous blood from the lower extremities and pelvis (iliac veins), liver (hepatic veins), and head, neck, and upper extremities (ductus arteriosus). The aorta divides into the two iliac arteries ; each of these in turn divides into (1) a hypogastric or umbilical artery (*au.*), giving off twigs to the pelvis, and then passing into the cord, and so to the placenta, and (2) an external iliac branch running to the lower limbs. The curious anomaly is thus presented that the arterial supply of the lower extremities is derived from the same trunk as the venous blood which is carried to the placenta to be purified. The blood carried to the placenta by the umbilical arteries passes through the villi, and is returned in a purified state to the fœtus through the umbilical vein (*vu.*).

Changes in the Fœtal Circulation at Birth.—These are due to two causes : (1) the expansion of the lungs by respiration ; (2) the arrest of the placental circulation. The immediate effect of respiration is to divert a great part of the blood from the right ventricle to the lungs, and the

ductus arteriosus accordingly becomes greatly contracted. The immediate effect of arresting the placental circulation is to reduce the pressure in the right auricle by diminishing the quantity of blood entering it through the inferior vena cava. At the same time the pressure in the left auricle is raised by the increased amount of blood returned to it from the lungs ; the pressure in the two auricles is thus more or less equalised, the flap valve of the foramen ovale closes, and the passage of blood from the right to the left auricle is arrested. The umbilical vessels, ductus arteriosus, and ductus venosus become gradually occluded by thrombosis, but all may persist in the form of fibrous cords in the adult. The transition from the fœtal to the adult type of circulation is probably completed in a few days.

General Physiology of the Fœtus.—The placenta subserves the functions of respiration and nutrition, and through it the fœtus obtains all the oxygen and nutritive materials it requires. We know practically nothing of the manner in which the materials absorbed from the maternal blood are worked up into the fœtal tissues. There can be no doubt that large quantities of fat, for example, are produced in some way in the body of the fœtus, for Fehling has shown that the proportion of fat increases from 0·45 per cent. of the body-weight at the fourth month to 9·1 per cent. at term. As fat is a non-diffusible substance it cannot pass through the placenta, and therefore must be elaborated by the fœtal organs themselves.

Attention has been already drawn to the large size of the fœtal liver in the early months, and to the remarkable arrangements for supplying it with purified blood. At the fourth week of gestation the fœtal liver has attained a predominant size among the abdominal viscera ; during the second month this predominance increases, causing protuberance of the upper abdomen. In the later months it becomes proportionately smaller, but even at term it is unduly large, for it weighs one-eighteenth part of the total body-weight of the fœtus, while the proportion in the adult is one-thirtieth. In the third month the gall-bladder contains a yellow fluid in which bile salts and acids can be detected, and which is therefore a true biliary secretion. Bile pigment appears later ; but glycogen and urea, both

products of hepatic activity, are also present in the fœtal tissues at an early period of development. There can be very little doubt that the liver plays an important *rôle* in fœtal physiology, which may perhaps be as much constructive as excretory.

The chief excretory organs—the kidneys and the skin—are also functionally active in the fœtus. We do not know the precise period at which the kidneys begin to secrete urine, but during the last two months of development the bladder usually contains a little clear fluid in which urea, albumen, and chlorides can be detected, and which is therefore a true renal secretion. Sebaceous glands appear in the skin at the fifth month, the sweat-glands somewhat later. The structure of the fœtal epidermis is very simple, the horny layer being practically absent, and transudation from the fœtal capillaries into the liquor amnii probably takes place with ease. The traces of urea found in the amniotic fluid may therefore reach it directly from the blood by passing through the skin. The vernix caseosa is the abundant product of the active sebaceous glands. The meconium found distributed in the gut of the mature fœtus, from the duodenum to the rectum, is chiefly composed of the waste products of the hepatic secretion. It also often contains numbers of lanugo hairs and squamous epithelial cells, which can be recognised under the microscope ; the only possible way in which they can reach the intestine is by the fœtus swallowing quantities of its liquor amnii, in which these elements are always to be found in suspension. The uniform distribution of this substance throughout the gut indicates that peristalsis is present in the fœtal intestines, otherwise accumulation in the upper part would necessarily take place.

The Gravid Uterus

The uterus undergoes a remarkable series of changes during pregnancy, which are without parallel in any other organ. They result in an increase of weight from $1\frac{1}{2}$ to 2 ounces before impregnation, to 2 to $2\frac{1}{2}$ lbs. at term.

Changes in Shape and Size.—During the first month of gestation the uterus undergoes no clinically appreciable alteration in shape or size, but towards the end of the second

month well-marked alterations are apparent. The body of the normal non-gravid uterus has the shape of a pear flattened in an antero-posterior plane; during the second month it expands in the antero-posterior plane, but is still wider at the fundus than below. At the eighth week the uterine body measures about 2 inches in vertical by $1\frac{1}{2}$ inches (5 cm. by 4 cm.) in transverse diameter (Fig. 43). The

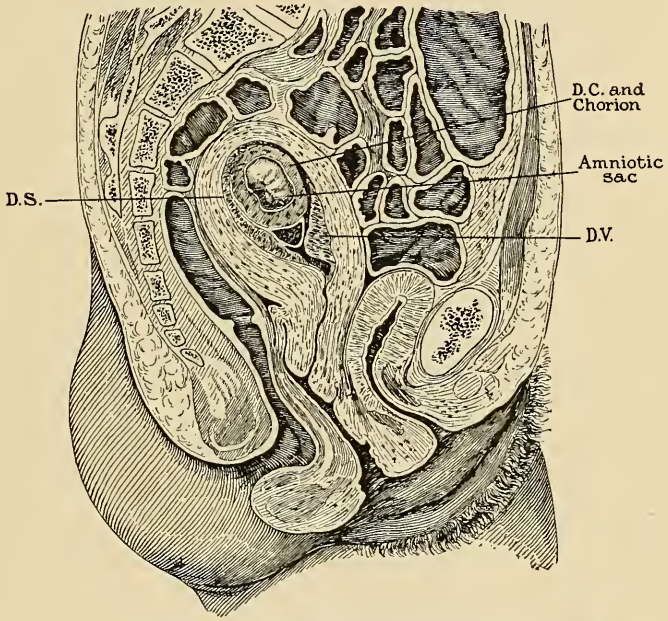


Fig. 43.—Gravid Uterus at End of Second Month (Eighth Week). From a Frozen Section. (Braune.)

The uterus is retroverted, but shows the expansion of the body-cavity. D.C. Decidua capsularis. D.S. Decidua basalis (serotina). D.V. Decidua vera.

normal anterior inclination of the uterus is now somewhat exaggerated, and the angle between body and cervix may be slightly diminished (anteflexion). At the end of the third month (twelve to thirteen weeks) it is nearly globular in shape, and has greatly increased in size, measuring about $3\frac{1}{2}$ to 4 inches (9 cm. to 10 cm.) in diameter (Fig. 44). It has now become large enough to fill the pelvic cavity, and in a primigravida (a woman pregnant for the first time) may be felt just above the level of the pubes on abdominal

palpation. In a multipara it is often higher than this. At the end of the fourth month it has again become distinctly

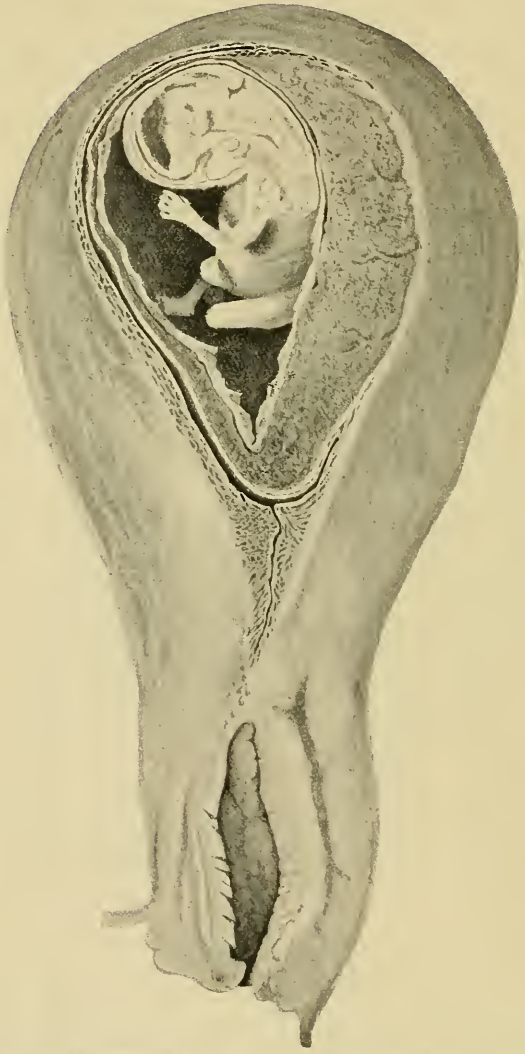


Fig. 44.—Gravid Uterus at the Thirteenth Week. (Galabin and Blacker.)

pyriform in shape (Fig. 45); the vertical diameter is about 6 inches (15 cm.), and the fundus may be felt somewhat nearer the umbilicus than the pubes. The pyriform shape

is henceforth preserved until term. Measurements of the height of the fundus above the pubes are somewhat fallacious, but at the end of the fifth month (twenty-two weeks) the uterus usually extends to the level of the umbilicus; at the end of the seventh month (thirty-one weeks) it is

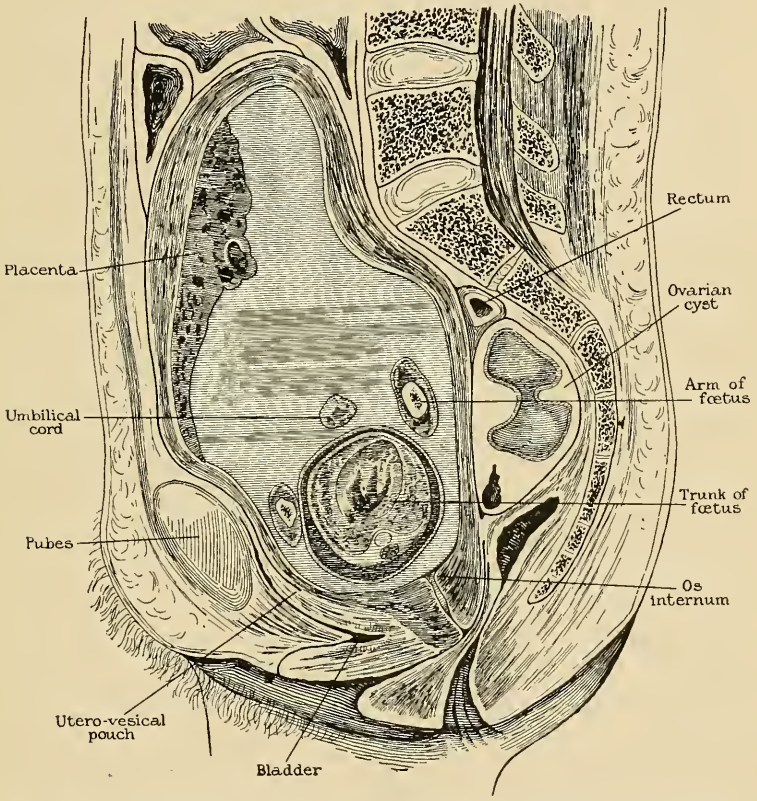


FIG. 45.—Gravid Uterus at Beginning of Fifth Month (Eighteenth Week). From a Frozen Section. (Clarence Webster.)

midway between the umbilicus and the tip of the xiphoid cartilage; the highest point is reached about two weeks before term, when the fundus extends to the tip of the xiphoid cartilage, and often passes upwards beneath the costal margin slightly everting the lower ribs. It then sinks a little lower in the abdomen; this descent is, however, not observed in every case, and may be delayed until labour

has actually commenced. The average height of the fundus above the pubes at term is about 10 to 12 inches (25 cm. to 30 cm.), being a little greater in a multipara than in a primigravida : the widest transverse diameter of the uterus is $8\frac{1}{2}$ to 9 inches (21 cm. to 22 cm.). As seen in frozen sections, the uterus from the fifth month onwards is markedly moulded posteriorly upon the vertebral column (Figs. 45 and 46).

The ovum does not completely fill the uterine cavity until the end of the third month (Figs. 15 and 44) ; until then a space persists, known as the *decidual space*, lying below, or below and to one side of the ovum. During the fourth month the decidua vera and capsularis become closely apposed, obliterating this space, and bringing the ovum directly over the os internum (Fig. 45) ; the same relation is thence maintained to term.

Changes in Relations.—The position of the gravid uterus after it has risen out of the pelvis is rarely precisely mesial ; it is usually deflected to one or other side, more often to the right than the left. This is called the *lateral obliquity* of the uterus. It is also believed that rotation on a vertical axis occurs, bringing one or other—usually the left—cornu forwards towards the abdominal wall. This rotation can sometimes be observed when the uterus is exposed in the operation of Cæsarean Section. The normal position of anteversion (tilting forwards) of the body of the uterus is often exaggerated during the first two months ; afterwards the uterine axis becomes almost erect ; later still the organ becomes moulded upon the vertebral column, and towards the end of pregnancy the tendency to anteversion again appears, especially in multiparæ with lax abdominal walls (Fig. 50) ; these changes in the degree of anteversion produce corresponding variations in the position of the cervix which are appreciable to clinical examination. Thus during the first two months the cervix is carried backwards by exaggerated anteversion of the fundus, until the external os is difficult to reach with the finger. Later on it becomes more central, and the os is easily reached. As term approaches the cervix again becomes displaced backwards by descent of the head, and it may be quite difficult to reach it when labour sets in.

The relations of the uterus to its peritoneal investment undergo considerable changes. The uterine peritoneum develops *pari passu* with the growth of the uterus, and the anterior and posterior peritoneal pouches are preserved (Figs. 45 and 46). The utero-sacral folds rise up to the level of the pelvic brim, and since the level of its floor remains unaltered, the pouch of Douglas at term is very deep indeed.

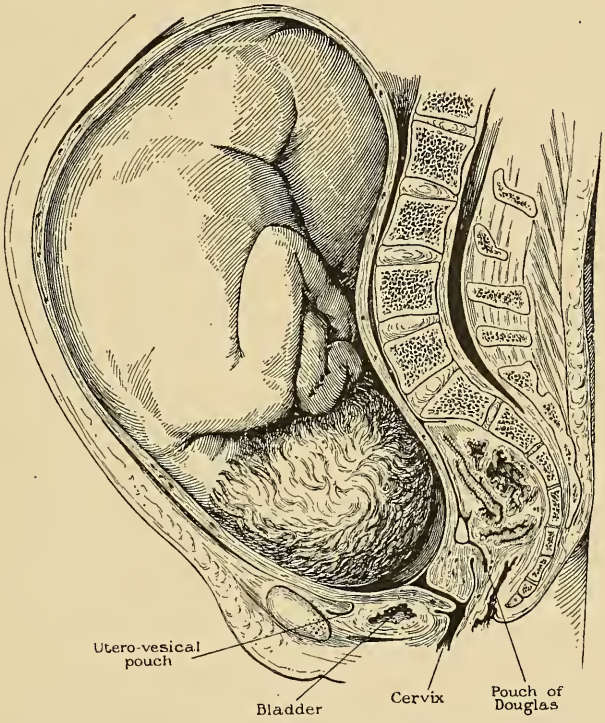


FIG. 46.—Frozen Section of Gravid Uterus at Term. (Leopold)

The lateral reflections also rise considerably, so that at term the bases of the broad ligaments may be described as being at the level of the pelvic brim (Barbour); this leaves a large area of the lowest part of the uterine wall on each side uncovered by peritoneum. Considerable increase of connective tissue between the folds of the broad ligament, in relation to each lateral uterine wall, occurs during pregnancy. The round ligaments undergo considerable hypertrophy, so that they may in some circumstances be palpated through

the abdominal walls. The bladder remains a pelvic organ up to term, and the level of the utero-vesical pouch is unaltered throughout pregnancy (Fig. 46).

Changes in the Uterine Muscle.—The presence of a developing ovum in the uterus sets up a progressive series of changes in that organ of a hypertrophic character, the immediate effect of which is to enable the uterus to contain the fœtus during the whole period of its growth. These changes in the uterus may be suitably designated as "active dilatation." They must be regarded as a part of the general physiological reaction of the maternal organism in pregnancy, to which further reference will shortly be made.

The average thickness of the uterine wall at term is about half that of the non-pregnant organ, which is from $\frac{3}{4}$ to 1 inch (2 cm. to 2·5 cm.), but there are variations in different parts. The posterior wall is fairly equal throughout ; the anterior becomes thinner in its lower part before it joins the cervix. Both hypertrophy of existing muscle fibres, and new formation of muscle, occur in the gravid uterus. Increase of the elastic tissue is also said to occur, but the connective-tissue elements of the uterus are, generally speaking, much less affected than the muscular elements. According to Kölliker, the muscle fibres in the second half of pregnancy are ten times as long and twice as broad as in the non-gravid state. New formation of muscle fibres only occurs during the first six months, and affects chiefly the deeper layers of the musculature. The fibres are said to become striated to some extent towards the close of pregnancy. During the course of pregnancy a more or less definite arrangement of the musculature of the body of the uterus into three layers occurs, but this change does not affect the cervix. The *outer* layer consists partly of longitudinal, partly of transverse fibres ; the former are found in the form of a broad mesial band, running from the level of the internal os in front over the fundus to the same level behind ; the latter cross the uterus in front and behind and pass out into the broad ligaments. The *middle* layer greatly exceeds either of the other two in thickness and is closely united with them ; it forms a close reticulum of interlacing fibres, through which run the large arterial and venous channels ; around the vessels it forms powerful rings of arcuate fibres arranged somewhat in the form of figures of

8. The *internal* layer is very thin, and is composed mostly of annular fibres, which encircle the whole uterus, and are specially developed at the cornua around the openings of the Fallopian tubes.

The Lower Uterine Segment.—It has been mentioned that the lower part of the anterior uterine wall becomes thinned for a short distance above the level of the internal os. Over this part the peritoneal coat is loosely attached, and can be readily stripped off. It will be remembered that in the non-gravid uterus the peritoneum is loosely attached in the same position. Upon the posterior wall there is neither thinning of wall nor loose attachment of peritoneum. The part of the uterine body roughly corresponding to the area of loose peritoneal attachment is called the *lower uterine segment.* It was until recently believed that the lower segment could be *precisely* defined in this manner, but it now appears that the area of loose peritoneal attachment is subject to much greater variation than was formerly supposed (Barbour). Although defined in this way only upon the anterior wall, the lower uterine segment forms a complete zone. It is said that microscopically the arrangement of the bundles of muscle fibres is somewhat different in the lower segment from the remainder of the uterus (Barbour). Its special functions are connected with the process of labour, and the subject will be again referred to in that connection (see p. 274). The normal situation of the placenta is any part of the uterine wall above the lower segment ; when the placental site encroaches upon this part of the uterus the condition of *placenta prævia* is produced. The development of the lower segment in pregnancy can be traced roughly by measuring the distance between the internal os and the level of firm peritoneal attachment ; in this way it has been shown to increase from 2·3 cm. at the fourth month to 6 cm. at term. From what has been said of the relations of the peritoneum it will be perceived that at term the lateral aspects of the lower segment have no peritoneal investment, for they lie between the layers of the broad ligaments, the bases of which are greatly elevated.

The Cervix undergoes few alterations of importance during pregnancy. It preserves the naked eye characters of its mucous membrane, which does not become transformed into a decidua (Fig. 44). It has recently been shown, however,

that decidual cells may be found in the upper part of the cervical mucous membrane, and it is therefore probable that the changes characteristic of pregnancy do not end abruptly at the internal os, but may be traced in diminishing degree into the cervix (Aschoff). Its muscular coat does not hypertrophy, and it preserves the usual arrangement of its fibres in a dense network. Its relations to vaginal vault, cellular tissue, and peritoneum remain unaltered. It was formerly believed, from clinical observations, that the cervix became shortened during pregnancy ; the study of frozen sections of the gravid uterus *in situ* has shown that the length of the canal is fairly constant and does not differ from that of the non-gravid organ (Fig. 97). Clinically, however, a marked change occurs which is known as ' softening of the cervix.' It is found first at the lips of the os externum and gradually advances from below upwards until at term the whole of the portio vaginalis is softened. The histology of this change is obscure, and up to the present time no satisfactory study of it has been made ; increased vascularity probably explains it in part. The surface of the portio vaginalis undergoes a variable degree of blue discoloration early in pregnancy. As term approaches the internal os often becomes a little dilated in a multipara, and the same change is occasionally found in a primigravida.

Uterine Contractions.—Throughout pregnancy the uterine muscle manifests a certain amount of activity. Intermittent contractions take place, feeble in the early months, but becoming more pronounced as the uterus develops, which bear a general resemblance to the uterine contractions, or ' pains,' of labour. They are intermittent and involuntary, but they differ from the contractions of labour in being painless—the patient is quite unconscious of them. Being palpable by abdominal examination, they form a clinical sign of great diagnostic importance in the later months of pregnancy. They are probably excited by some reflex mechanism, in which the ovum provides the peripheral stimulus ; while the active hypertrophy of the uterine muscle makes the response to this stimulus very pronounced. Even when spontaneous contractions are imperceptible, hardening and contraction of the uterus can usually be induced by a gentle stimulus, such as rubbing with the hand.

The General Physiology of Pregnancy

The presence of a developing ovum in the uterus occasions a progressive series of changes not only in the containing organ but in the whole of the maternal organism. In addition to the uterine changes, widespread alterations occur involving both the structure and the function of many of the most important organs in the body. There can be no doubt that a potent physiological force resides in the developing ovum and scarcely a single function of the maternal organism but feels its influence. The recognition of the existence of this force is the chief contribution which has been made in recent years to the science of obstetrics. The study of the question naturally presents great technical difficulties, and demands expert biological and biochemical knowledge. The practical obstetrician can do no more than carefully examine the work of scientific observers, and endeavour to gather from their results a general view of the problem which may be useful in understanding clinical phenomena, and in dealing with abnormal developments.

The General Physiological Changes in Pregnancy.—Under this heading must be grouped not only the well-known and obvious changes such as those which occur in the breasts, but also the recently discovered and more obscure alteration which occurs for instance in the endocrinous glands and in the blood serum. Physiological forces must be studied mainly through the effects they produce; at this early stage of our knowledge, therefore, it will be necessary to speak chiefly of structural and chemical changes, and little of the manner in which they are brought about.

Mammary Glands.—These organs cannot be said to be fully developed until pregnancy has occurred, and has been followed by a period of lactation. In a primigravida (a woman in her first pregnancy) they undergo a series of changes, many of which persist after the glands have returned to their resting phase; the breasts of a parous woman who has suckled her children therefore differ greatly from those of a nullipara. The size of the mamma is very variable in healthy women, as are also the size and appearance of the nipple and areola. In a first pregnancy the whole gland increases in size, and undergoes a true hypertrophy, which affects not

only the glandular acini, but also the connective-tissue stroma (Fig. 47). This hypertrophy is first recognisable clinically in the peripheral lobules of the gland, which become tense, nodular, and slightly tender to the touch. It usually appears at about the end of the second month, although it may be delayed until the fourth month. When the hypertrophy of the lobules is well marked, a little clear pale-yellow secretion can usually be expressed by gently compressing the base of the gland and squeezing it towards the nipple. The nipple and areola become more deeply pigmented, but this change varies much in intensity in women of different complexion, being more marked in brunettes than in blondes. Upon the areola a series of ten to twenty small non-pigmented nodules appear, consisting of enlarged sebaceous glands, and known as 'Montgomery's tubercles' (Fig. 48); they are not, however, invariably present. Usually the areola becomes more prominent than normal, and around it is formed an outer zone of irregular and less marked pigmentation, known as the *secondary areola*. As shown in Fig. 48, the secondary areola usually consists of a well-defined reticulum, forming a tesselated arrangement of pale quadrilateral areas enclosed in the meshes of a pigmented web. An increased vascular supply, indicated by dilated veins under the skin, accompanies the hypertrophy. Often towards the close of a first pregnancy the skin itself becomes stretched, and small patches of the cutis vera becoming thinned, give rise to the appearances known as *striæ* (see p. 75). The secretion varies in character during pregnancy; when first seen it is usually a thin straw-coloured

Fig. 47.—The Mamma in a late stage of Pregnancy, showing the Secondary Areola. (Galabin and Blacker.)

fluid resembling serum; later it becomes thicker, more opaque, and more distinctly yellow in colour.

In the breasts of a multipara the changes characteristic of early pregnancy can seldom be detected, for the reasons stated above. After a period of full functional activity (suckling) a little *milk* may be present in the breasts for several years and may be found on squeezing them. But if the breasts of a multipara contain thin serous fluid instead

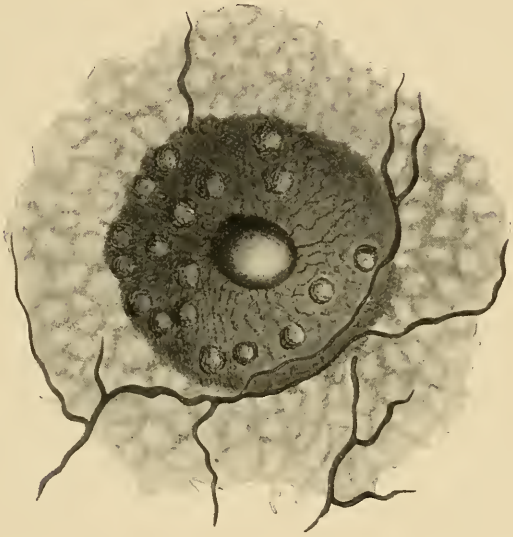


FIG. 48.—The Nipple and Areola of a Primigravida, showing the Tubercles of Montgomery, the Secondary Areola, and several dilated veins.

of milk, a fresh phase of activity, *i.e.*, an early pregnancy is indicated.

These changes indicate an ' activation ' of the mammary glands during pregnancy, which is recognisable from the second month onwards. In degree and in the rate of advance considerable variation may be noted, but the glands never remain absolutely quiescent during pregnancy. The acme of the process of activation does not occur however, until three or four days after the birth of the child (see p. 559). The breasts then become engorged with secretion to an extent which makes them swollen and painful, but which is

fully relieved by the natural process of suckling. Once fully established, mammary activity will be maintained for several months, under the stimulus of suckling, without the renewal of the original physiological stimulus. Occasionally puerperal activation is deficient, and the mother has not enough milk to feed her child.

The means by which pregnancy induces mammary activity are not known, but there can be no doubt that there is a direct relation of cause and effect between them. No other condition than pregnancy can excite the mammary function to anything like the same extent; the stimulus is continuous and progressive in intensity throughout pregnancy; untimely interruption of pregnancy leads to immediate mammary retrogression. The physiological mechanism at work is probably complex. Biochemical changes are no doubt the main factor, and in accordance with the physiological nomenclature of to-day it may be said that a 'hormone' is probably produced in the gravid uterus, which directly or indirectly acts upon the mammary gland. Whether the hormone is of maternal or fœtal origin is not determined, and the point is not of great importance. Starling and Lane-Claypon experimentally produced mammary hypertrophy in virgin rabbits by injection of extracts made from the fœtus of the rabbit, and from this result they conclude that the mammary stimulus is of fœtal origin. These conclusions, however, must await confirmation. The fact that mammary activity persists for so long after the production of the pregnancy 'hormone' has ceased, indicates that the action is indirect. It has been suggested by Schäfer that this indirect action may be exerted through the pituitary gland. It is known that in animals this gland undergoes well marked hypertrophy in pregnancy; if it may be assumed that the same change occurs in women, then the persistence of this hypertrophy may explain the hypersecretion of the early puerperium and the continuance of activity, aided only by the mechanical stimulus of suckling, during the period of lactation.

Cutaneous System.—The changes occurring in the cutaneous system may be arranged in two groups; some are *mechanical* and are due to stretching of the skin, such as the striæ; others are truly *biological*, such as pigmentary

changes, malnutrition of the cutaneous appendages, and the appearance of eruptions.

Striæ gravidarum appear on the abdominal wall similar to those found on the breasts. When recently formed they are pearly or pinkish in colour, and linear in outline ; they vary in length and breadth, and are most marked below the umbilicus ; sometimes they are also seen on the adjacent parts of the buttocks and thighs. After labour is over they become pale and silvery, *i.e.* cicatricial, and are known as *striæ albicantes.* In a multipara some may be found in the recent state, others are old, and represent the changes which have occurred in a previous pregnancy. The capacity of the skin to resist the effects of stretching varies in individuals, for sometimes these marks are not produced at all in pregnancy. On the other hand, similar striæ may be produced by abdominal distension due to causes other than pregnancy.

Pigmentary changes.—The changes in the breasts have been already referred to. On the abdomen a mesial line of pigmentation, running from above the umbilicus to the pubes, appears during the second half of pregnancy ; it is called the *linea nigra.* In a dark complexioned woman it may be broad and dark and in a fair woman it may be barely visible. In dark complexioned, non-pregnant women a similar line may sometimes be seen, so that its presence is not a sure indication of pregnancy. On the face irregular patches of dark brown pigmentation sometimes occur, being most marked on the forehead, the sides of the nose, and the upper lip, but the whole face may be affected. It is called the pregnancy mark or *chloasma.* Sometimes extensive pigmentation occurs on the trunk in irregular patches, alternating with patches from which the natural pigment has largely disappeared. In some cases the distribution is not unlike that seen in Addison's disease. As a rule the pigmentary changes disappear after labour, but sometimes, on the trunk, they remain permanent.

Signs of malnutrition may be found, such as an increased tendency to falling of the hair ; in the same category, as teeth are of epidermal origin, may be placed the rapid advance of dental caries.

Eruptions of erythematous, papular, or pustular type

are frequent accompaniments of morbid complications of pregnancy.

Circulatory System.—The *blood* undergoes modifications which are fairly constant, and upon which observers are agreed. In animals the total volume of the blood is increased during pregnancy, and the same change can fairly be assumed to occur in women. The quality of the blood, however, deteriorates, for the proportion of water increases, while the proportions of red cells and hæmoglobin diminish ; these evidences of anæmia are most marked about the middle of pregnancy, but even at term the average number of red cells is under 4,000,000 per cmm. A definite excess of white corpuscles is found in the blood during pregnancy, the excess being much higher in a primigravida than a multipara. It is most marked towards the close of pregnancy, when the numbers vary from 8,000 to 15,000 (Carton). During labour a further increase up to 20,000 occurs, and after labour the number may reach 25,000 (Pankow), but thereafter rapidly falls. The specific gravity is progressively diminished up to the middle of pregnancy, and rises again to normal at term. The amount of calcium salts present is slightly increased, while that of fibrin diminishes up to the sixth month, when it begins to rise again to normal at term. It will thus be seen that a certain deterioration in the quality of the blood is evident during the first half of pregnancy.

The *heart* was for a long time believed to undergo hypertrophy during pregnancy. There has been much conflict of observation upon the point, but Löhlein asserts that the weight of the organ is not appreciably increased, and therefore there can be no hypertrophy. A certain amount of dilatation probably occurs, affecting chiefly the right side of the organ. *Arterial tension* is believed to be increased slightly during pregnancy, but it is very variable, and clinical observations have failed to settle the question definitely. In the *venous system* evidences of increased back-pressure are frequently found in the form of hæmorrhoids, slight anasarca of the feet, and varices of the lower extremities and vulva.

Blood pressure is believed to be slightly raised during the later months of pregnancy, but great differences of opinion exist as to what is the normal for young adult non-pregnant women. From recent clinical observations Bailey estimates

that a pressure of 118 mm. of Hg is normal for the last month, and this is hardly above the average. In certain morbid conditions, notably eclampsia, a high blood pressure, which may reach 150 mm. to 200 mm., is commonly found, but the point is not one of practical importance when conditions are normal.

The Endocrinous (Ductless) Glands.—Recent investigations have shown that these organs undergo remarkable changes in the direction of 'activation' in animals, and it may be assumed with confidence that they occur in women also. It has been known to clinical observers for generations that goitre underwent rapid enlargement during pregnancy, and careful observation has shown that the normal gland often undergoes enlargement also. The other endocrinous glands are inaccessible to clinical examination, and confirmation of their participation in pregnancy-enlargement can only be gathered as opportunity offers. It may be said, however, that in animals the pituitary, the pineal, the adrenals, the thymus, and the parathyroid bodies all show enlargement accompanied by minute changes in their cells indicative of hyperactivity. The conclusion is that the amount of their internal secretion is raised above the normal, and the physiological effects they produce are exaggerated. The functions of these glands are by no means fully known, but certain of the general effects of pregnancy already described may very well be due to them. Thus the activation of the mammary glands and the rise in blood pressure may be brought about indirectly through the pituitary, the pigmentation of the skin through the adrenals, the leucocytosis through the spleen, and the increased output of calcium through the ovaries.

Other Organs.—The *nervous system* becomes functionally disturbed in women of neurotic tendencies, and such conditions are manifested as irritability, sleeplessness or constant drowsiness, neuralgia, perversion of appetite by the so-called 'longings,' &c. But in women whose nervous system is in a state of stable equilibrium these disturbances of function do not occur. Towards the end of pregnancy the size of the uterus causes some embarrassment of respiration, which becomes almost entirely costal in type; and cramps in the muscles of the legs are frequent from pressure upon the lumbar

and sacral plexuses. The *bladder* usually shows some irritability about the second month, but this passes off and does not recur until the close of pregnancy, when not uncommonly micturition again becomes frequent and painful. *Nausea and vomiting* are usually present in the early months (see Morning Sickness, p. 85), and there is a common tendency to constipation and the formation or aggravation of hæmorrhoids. A slight decrease in the total acidity of the gastric secretion and in the amount of free hydrochloric acid accompanies pregnancy. The *pelvic articulations* undergo slight softening of ligaments and general loss of firmness and strength.

The liver also enlarges and becomes congested, and certain recent observers have maintained that a zone of slight fatty degeneration may be found in the centre of the hepatic lobule around the portal vein, which is dilated. It has been shown that the glycolytic function of the liver is diminished, and further evidences of disordered function are to be found in the diminished excretion of extractives by the kidneys.

There is also evidence that many other organs, not directly connected with the generative system, show definite changes in pregnancy. Thus, patches of congestion and swelling of the mucous membrane of the larynx commonly occur, resulting in alteration of the tone and quality of the voice in singers. Similar patches of congestion and swelling occur in the mucous membranes of the bladder and ureter.

Excretory Functions.—It has been known for a long time that the amount of carbonic acid thrown off by the lungs is distinctly increased during pregnancy. Observations upon the functions of the skin have not been made, but great attention has of late years been paid to the condition of the urine, and the following facts have been established. The daily quantity of urine is frequently below the average in primiparæ. The proportion of total solids diminishes steadily up to term, the fall being due to diminution in the amounts of uric acid, urea, phosphates, sulphates, creatin, and creatinin. A fair average excretion of urea for a pregnant woman on an ordinary mixed diet is estimated at 1·25 per cent. Of the total nitrogen excretion the proportion excreted as urea is normal, but the proportion excreted as ammonia is slightly increased. A study of the nitrogen

intake and output has shown that towards the end of pregnancy the mother is storing nitrogen at a rate considerably in excess of the nitrogenous requirements of the fœtus, which are estimated at 1 grain a day. Sometimes sugar is found in the urine of healthy pregnant women towards term, and this has been shown to be due, in most cases, to lactose derived from the mammary secretion, although alimentary glycosuria may also occur. Lactose is also very frequently found in the urine of nursing women. It will be observed that the solid constituents of the urine which are diminished are chiefly 'purin bodies'—urea, uric acid, creatin, creatinin—and disturbance of the functions of the liver is probably the cause of this alteration.

Recent observations have shown that during normal pregnancy the excretion of lime salts is greatly increased, and an excess is usually to be found in the blood. This appears to result from a certain decalcification of bone, as the amount excreted exceeds that ingested in the later months of pregnancy. The excess in the blood may in part be used for the processes of fœtal ossification.

The glycolytic function of the liver is also impaired during pregnancy, and according to Bar it is reduced to one half of the normal. This is evidenced by the rapid appearance of sugar in the urine after ingestion.

Elaborate chemical investigations of the excretory functions in pregnancy have been carried out by Bar, who has estimated the relation between the ingestion in foodstuffs, and the excretion through the urine and fæces, of nitrogen, lime salts, phosphorus, &c. The details of such an investigation are unsuitable for consideration in a text-book; the general conclusion at which Bar arrived may, however, be stated. He considered that his observations showed that definite alterations in the maternal metabolism are recognisable in pregnancy, the assimilation and output of the chief tissue constituents being regulated so as to provide what is required for the formation and growth of the fœtus. So accurately is metabolism adjusted that the maternal organism suffers no loss during pregnancy, but can be shown actually to lay up larger stores of certain elements. He was thus led to regard the state of pregnancy as a 'harmonious symbiosis.'

Other observers have been led in the opposite direction, viz., to the conclusion that a condition of *toxæmia* is developed during pregnancy. The earliest observations of this character were those of Bouchard upon the toxicity of the urine. The methods employed are necessarily somewhat complex, and they cannot be described here in detail ; but it may be said briefly that they consist in determining the amount of urine which will produce death when injected directly into the vein of an animal, usually a rabbit or guinea-pig. This is called the *urotoxic dose*, and it can be compared with the urotoxic dose of the urine of a healthy non-pregnant woman, which is taken as the standard. If the urotoxic dose is larger in the pregnant than in the non-pregnant, then the toxicity of the urine is less, and *vice versâ*. Contradictory results have been obtained by this method, and extreme care is required in conducting the observations ; a majority of observers, however, assert that a slight diminution in the toxicity of the urine can be detected from the end of the second month up to term, but it rapidly disappears after labour. From this basis a theory has been built up that a toxic condition of the blood exists in normal pregnancy, for if less toxic matter is excreted it must be assumed to accumulate in the blood ; and this is called the *toxæmia of pregnancy*. Confirmation of the theory has been sought by making observations in a similar manner upon the toxicity of the blood-serum of pregnant women ; but the results of these observations are of very little value, owing to difficulties of experimental technique. It is, however, obvious that if an increase in the toxicity of the blood could be experimentally proved to occur during pregnancy, the existence of a condition of ' toxæmia ' could not be denied. For the present it must be said that these observations have not succeeded in demonstrating the existence of a toxic condition of the blood in *normal* pregnancy ; but, as we shall see later, they have been of great service in throwing light upon the causation of some of the disorders of pregnancy.

In the last few years the matter has been carried further by numerous observations upon the serum reaction in pregnancy, which will now be referred to.

Serum Reactions in Pregnancy.—The greatest advance which has been made in recent years in the study of the

biology of pregnancy is the discovery by Abderhalden of a specific serum reaction, which is now known as Abderhalden's test.

This test is based upon the principle, now well established by numerous instances, that the introduction into the blood of an organic foreign substance leads to the formation of a special ferment which will destroy it. Thus cane sugar injected into the blood leads to the formation of a ferment —invertin, which reduces it ; injection of foreign proteids leads to the formation of proteolytic ferments which break them up. Each ferment thus produced is specific, *i.e.*, it is able to break up only a particular proteid. Abderhalden's plan was to try to discover whether the blood of a pregnant woman contained a ferment capable of destroying placental proteid.

The fact that fragments of chorionic epithelium enter the maternal blood vessels, and are carried to distant parts, has been already referred to. One of the first observers of the migration of fragments of syncytium into the blood-stream was Veit. His observations led him to conceive the idea that the presence of this substance in the blood might be deleterious, and might become the means of exciting the production of a protective body or antigen, the function of which would be to destroy the syncytium. To this hypothetical protective body he gave the name of *syncytiolysin*. It will be obvious that Abderhalden's test takes up the idea enunciated by Veit, and seeks to put it to a biological proof. Abderhalden desired to find out whether these fragments of fœtal epithelium are disposed of in the blood by a ferment.

The details of Abderhalden's test are very complicated, and only an outline can here be given. The isolation of the ferment itself being impracticable, his test aims at the detection of substances known to be end-products of the process of proteolytic digestion of all kinds of proteids.

The first step is to prepare from fresh normal placental tissue, carefully freed from blood and handled with infinite precaution, a solution of placental *peptones*, by partial digestion with an acid. Blood serum from a pregnant woman, and serum from a non-pregnant woman for use as a control, are then brought into contact with the placental

peptone solution. The former freely breaks up the peptones ; the latter does not, or does so only to a slight extent. The destruction of the peptones is demonstrated by recognising in the solution *amino-acids*, known to be the end-products of proteolytic digestion. Two methods of demonstrating amino-acids may be employed, viz., by the polarimeter, or by dialysation and a colour reaction ; the latter, although much more complex, is also more delicate, and by it a dilution of 1—25,000 may be detected.

By this test Abderhalden claims to have proved that the blood serum of a pregnant woman contains a specific substance, of the nature of an enzyme, which possesses the power of breaking up placental proteids ; that the blood of non-pregnant women does not contain this body ; and that, in consequence, the biological reaction which he has discovered may be used as a means of diagnosing pregnancy. He further claims to have shown that fœtal blood does not contain the ferment. It must, however, be stated that some observers, working with the test, have failed to corroborate Abderhalden's results, while other workers, in confirmation of Abderhalden, have shown that positive reactions may be obtained in pregnancy from the eighth week onwards, and also up to the tenth day of the puerperium.

Evidence is accumulating that there are many sources of error to be guarded against in the application of the test, which can only be carried out by an expert pathological chemist. Unless due precautions are observed, positive reactions in the non-pregnant may be obtained. At the same time the main features of Abderhalden's test have now been confirmed by numerous workers, and according to Williamson, it holds good for extra-uterine as well as for normal pregnancy, and perhaps even for chorion-epithelioma.

The significance of these observations, if they can be relied upon, is undoubtedly very great. They indicate that there is present in the blood of a pregnant woman a substance against which the organism must be protected, *i.e.*, a *toxic* substance, and that a specific means is organised for its destruction. And further, they show that it is derived from fœtal elements of the placenta, and that the blood of the fœtus itself does not contain the toxic substance. In

other words, the mother is constantly absorbing products derived from the placenta, which to her are noxious, and must therefore be disposed of. So long as the defensive mechanism is acting adequately, she may suffer no ill effects ; should the defensive mechanism break down, such ill effects may reasonably be anticipated, although we cannot foretell what form they may assume.

This biological reaction suggests an easy explanation of the profound and widespread changes in the maternal organism in pregnancy which have been already described. Some of them, such as the activation of the endocrinous glands, may be a part of the defensive mechanism ; others may be the unfavourable result of toxic influences. And further, it suggests that certain of the grave disorders of pregnancy, which will be described in a later section, may be due to accumulation of the placental toxins in the blood, either from failure of the defensive mechanism, or from excessive production of toxins. Pregnancy would appear to be a condition in which health and disease are very delicately balanced, and morbid influences are particularly liable to become preponderant.

Many trained workers are now engaged in the attempt to apply Abderhalden's work to the elucidation of the diseases of pregnancy, but the problems to be solved are very complex, and much remains to be done. Certain observers have endeavoured to show that, in addition to Abderhalden's reaction, other reactions can be obtained from blood serum which are characteristic of a condition of *immunity*, comparable to that which is developed in recovery from bacterial infection. This view would necessitate pregnancy being regarded as a *disease* of parasitic origin, comparable to a specific fever, and in the meantime it has not passed further than the stage of suggestion.

The Diagnosis of Pregnancy

The limits of age within which pregnancy may occur are very wide. It is rare before puberty, and even more rare after the menopause. Yet authentic instances of pregnancy have been observed at the age of eight or nine years in girls in whom menstruation had appeared abnormally early. And

several authentic cases have also been recorded after the menopause, one of these being a woman of fifty-nine who had ceased to menstruate for nine years (Depasse). It may, however, be said that pregnancy is extremely uncommon before thirteen and after fifty.

The nomenclature of the duration of pregnancy is somewhat confusing. In this country it is usual to speak of nine calendar months as the period of gestation, but this is inexact. It is agreed that the average duration of pregnancy is from 274 to 280 days ; neither of these periods represents precisely nine months, for the number of days in nine months is variable ; but the latter does represent exactly ten times four weeks. It would avoid confusion to estimate the duration of pregnancy in weeks instead of months.

During the second half of pregnancy the presence of a fœtus in the uterus can be directly recognised by palpation and auscultation. During the first half this is impossible, and diagnosis then depends upon the careful observation of a certain series of *symptoms* (facts elicited from the patient), and *physical signs* (facts observed by the physician). The practical value of being able to recognise pregnancy at all periods is very great, and the subject therefore demands the most careful attention.

I. **Diagnosis of Pregnancy during the First Half.—Symptoms.**—Those met with during this period are amenorrhœa, morning sickness, irritability of the bladder, discomfort and swelling of the breasts, enlargement of the abdomen, and ' quickening.' It must be understood that not one of these symptoms occurring alone, nor even all of them occurring together, can be regarded as conclusive evidence of pregnancy. They allow of the ' presumptive diagnosis ' of pregnancy, but a definite opinion should never be expressed in any case until a physical examination has been made. And further, until the tenth week has been reached, the changes in the uterus itself are not sufficiently definite to allow of a physical diagnosis being made unless the conditions are specially favourable.

Amenorrhœa.—Cessation of the menses is practically invariable in pregnancy ; cases are said to occur in which regular menstruation continues for the first two or three months, but they are extremely rare, when pathological

bleeding can be excluded. Even in double uteri, menstruation ceases as a rule, although only one half of the organ is gravid. Irregular hæmorrhage from pathological causes is not uncommon in pregnant women, but this should not be confounded with menstruation. Sudden cessation of the menses in a healthy woman habitually regular, and not near the age of the menopause, affords a strong presumption of pregnancy. Amenorrhœa usually, though by no means invariably, continues during suckling, and it is also common in chlorosis, in hysteria, and in some forms of insanity. In addition to its value as a presumptive symptom of the existence of pregnancy, amenorrhœa affords the best means of estimating its duration. It is usual to reckon the commencement of pregnancy from the last regular menstrual period. This method is certainly fallacious, for pregnancy may occur during a period of amenorrhœa due to some other cause, such as suckling; and it takes no account of the fact that the date of fruitful sexual intercourse does not necessarily correspond with the cessation of menstruation, but it is the best method which is available for the purpose. Sometimes, however, the duration of pregnancy must be estimated from other data, such as the size of the uterus.

It is not known why the presence of a developing ovum in the uterus causes the immediate arrest of menstruation. There is a certain amount of evidence that ovulation continues, or may continue, during pregnancy (see Superfœtation, p. 100), which makes the cessation of menstruation the more remarkable. It has been suggested that a body is produced during pregnancy which antagonises the internal ovarian secretion, and thus arrests the menstrual process. It is possible that such a body may be present also in the mammary secretion, which would account for the amenorrhœa of lactation. After the fourth month, when the decidual space has been obliterated, of course menstruation cannot occur, for the uterine mucous membrane has practically ceased to exist, except as a part of the placenta.

Morning Sickness.—This symptom is by no means invariable in pregnancy. The great majority of primigravidæ suffer from it, but in subsequent pregnancies it is frequently absent. It usually appears at the beginning of

the second month—*i.e.*, soon after the first suppressed period —and it varies greatly in severity. Some pregnant women are seized with nausea, ending in vomiting, immediately on rising or after their first meal ; the vomiting once over, there is no further discomfort nor any loss of appetite during the rest of the day. Others are subject to nausea, without vomiting, which may last for several hours and is more troublesome than the first-named variety. But in neither case is the general health affected, and the tongue remains clean. All gradations may be observed between this symptom and the serious disorder of pregnancy known as hyperemesis (see p. 126). Morning sickness in either of these common forms usually lasts for only a few weeks, rarely for more than three months. The modern tendency is to regard it as a toxic symptom. It must be remembered that in chronic alcoholism morning sickness, sometimes associated with amenorrhœa and abdominal enlargement, may be met with apart from pregnancy ; but the tongue is furred, and the careful observer will detect other changes characteristic of this condition.

Irritability of the bladder, shown by frequency of micturition with some pain or discomfort, is usual during the second and third months, and is caused in part by the pressure of the heavy anteverted uterus, in part by the congestion of the mucosa of the bladder previously referred to (p. 78). After the third month, when the uterus rises above the pelvic brim and becomes more erect, the pressure is removed, and this symptom disappears or becomes alleviated.

Enlargement of the breasts is often noticed early by a primigravida, but *enlargement of the abdomen* usually does not become manifest to the patient until the uterus rises well above the pubes, and therefore seldom attracts attention until the close of the first half of pregnancy. A multipara, owing to the laxity of the abdominal wall, usually notices abdominal enlargement earlier than a primigravida.

Quickening.—This term in its ancient significance means ' coming to life,' and indicates that the mother has become aware of the existence of something which is alive and moving within her. The first movements of the fœtus which are felt by the mother sometimes produce a sensation

of more or less severe nausea or faintness, and to this symptom the term ' quickening ' is applied. Many women do not experience it, and find it impossible to tell when the movements of the fœtus first became obvious to them, so gradual has been their development. When a definite history can be obtained, quickening is usually found to occur between the sixteenth and eighteenth weeks. Fœtal movements continue until the end of pregnancy and are chiefly important in the later months as an indication that the child is alive. The mother continues to be conscious of these movements, as a rule, unless the child dies.

Physical Signs.—During the first few weeks no changes occur which can be detected by clinical investigation, and unless the conditions are specially favourable the earliest period at which pregnancy can be diagnosed is the eighth week. We therefore take up the physical signs at the latter period.

Eighth Week.—At this period the breasts of a primigravida may present recognisable indications of activity, but frequently they show no change until the following month. Some hypertrophy of the peripheral lobules of the glands, indicated by a nodular feel and slight tenderness, may be apparent, while the areolar changes described on p. 72 may also be detected. Occasionally a little clear serum may be expressed by gently squeezing the base of the gland towards the nipple. In the case of a multipara no importance can be attached to the existence of these signs, as they frequently persist in a gland which has previously passed through the period of functional activity associated with suckling, or even with pregnancy alone. Secretion is also sometimes found in the breasts of non-pregnant nulliparous women suffering from uterine disease, such as a fibroid tumour.

Examination of the abdomen at this period is of no value, but *changes in the uterus* may be detected by a careful bi-manual examination. Softening of the lips of the os externum may be made out, but is not very marked, and may be mistaken by the student for the condition clinically known as ' erosion ' ; examination with a speculum will clear up this difficulty, unless erosion of the cervix and pregnancy co-exist. If the abdominal wall is thin and lax, the body of

the uterus can be taken between the fingers of the two hands, and its increased size, almost globular shape, and soft consistence detected. Another important change known as Hegar's sign must also be looked for.

Hegar's sign is the result of certain anatomical conditions which are characteristic of the second and third months of pregnancy. It will be recollected that at this period the ovum does not completely occupy the uterine cavity, an empty space being left in the lower part, called the decidual space. At this period also the walls of the uterus have become distinctly softened, and perhaps somewhat thinned.

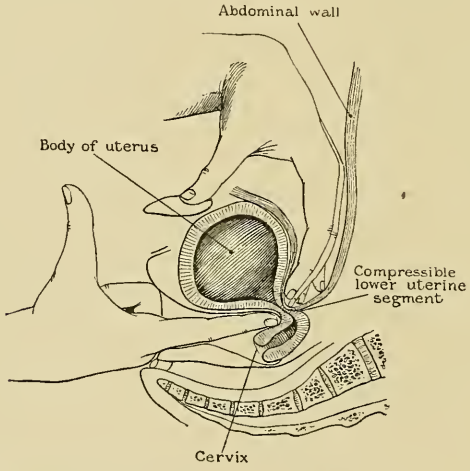


Fig. 49.—Schematic Representation of Hegar's Sign. (After Hegar.)

The body of the uterus is therefore in its upper part soft and distended by the ovum, in its lower part soft and empty. The lower part is consequently unusually compressible by the fingers in bi-manual examination, and Hegar's sign consists in the recognition of this unusual degree of compressibility. To obtain it, the uterus should be anteverted, although even in the retroverted position it can be elicited in a modified manner. Bi-manual examination is made with the patient lying on her back, the shoulders slightly raised, and the knees well flexed. Two fingers of the right hand are introduced into the vagina and placed immediately in front of the cervix ; the left hand is placed over the suprapubic region.

The uterus is then pushed upwards from the vagina towards the abdominal wall until it can be distinctly felt by the left hand. The fingers of the left hand are now passed over the posterior surface of the uterus, and when the two hands work together the lower part of the uterine body can be compressed between them (Fig. 49). Two points will then be noticed : first, the ease with which the fingers can be approximated and the walls of the uterus compressed ; and secondly, the tense elastic consistence of the upper part of the uterus, which forms a marked contrast to the lower part. When the uterus is retroverted, the compressibility of the lower part can be made out with a finger in the rectum and the other hand on the abdominal wall ; but the upper part of the body is not so easily accessible as in the position of anteversion, consequently the contrast between the upper and lower parts cannot well be made out. A certain amount of skill and experience in gynæcological examination is necessary for the recognition of this sign, but its value is very great when clearly perceived.

To sum up, it may be said that pregnancy at the eighth week can be diagnosed from the conjunction of the following series of symptoms and physical signs :

Symptoms.	*Signs.*
1. Amenorrhœa.	1. Slight breast changes (in a primigravida).
2. Morning sickness.	2. Lips of os externum softened.
3. Irritability of bladder.	3. Uterine body enlarged, softened, nearly globular in shape.
	4. Hegar's sign.

Sixteenth Week.—Amenorrhœa continues, but morning sickness and urinary symptoms have usually disappeared by this time. It is about this period that quickening is to be expected. The enlargement of the breasts has become quite obvious to the patient if she is a primigravida, but abdominal enlargement may not yet have attracted her attention.

Hypertrophy, increased pigmentation, and presence of secretion in the breasts can now, as a general rule, be made out. The linea nigra will be quite obvious in dark-complexioned women. The uterus is large enough to be felt rising to a height of about 3 inches above the level of the symphysis pubis. It forms an elastic, somewhat ill-defined,

mesial abdominal swelling, with a convex upper border. The characteristic dull violet coloration of the vulval mucous membrane is now recognisable, but its extent and intensity are variable. The cervix shows more extensive softening, and at this period forms one of the most characteristic and easily recognisable features of pregnancy. If exposed with a speculum the same violet coloration will be noticed as at the vulva. Pulsating vessels can often be felt at the sides of and behind the cervix—the enlarged vaginal arteries. The abdominal swelling can be recognised as the uterus by bi-manual examination ; its shape is now passing from globular to pyriform ; its consistence is intermediate between the hardness of a solid mass and the lax softness of a cyst, and is usually described as ' elastic ' ; but some experience is required to detect with confidence these varieties of consistence. Hegar's sign can no longer be made out. Two other signs of great importance can often be recognised at this period in the uterus—viz., *uterine contractions* and *internal ballottement.*

The fact that the gravid uterus undergoes *contractions* has been already referred to ; they are not recognisable clinically much earlier than the period under consideration, but it is possible that they exist in some form from the beginning of pregnancy. They are feeble contractions, and as detected at the end of the fourth month they merely render the uterus a little firmer and better defined in outline. Care and a prolonged *bi-manual* examination are required for their detection, for the intervals between them may be considerable ; they sometimes appear to be increased by manipulating the uterus. If the abdominal wall is thick or rigid, or the patient intolerant of the examination, this sign cannot be made out, and no importance must be attached to a failure to elicit it ; but its positive value is considerable. It sometimes occurs, however, apart from pregnancy, in soft fibroid tumours, and has been recognised in the enlarged uterus in cases of extra-uterine gestation. Sometimes partial or unequal contractions occur affecting portions only of the uterus ; as a result the shape of the uterus may be distorted and its consistence may appear to be different in different parts. After an interval it resumes its normal shape and uniform consistence.

Internal ballottement consists in the detection in the uterus of a movable solid body surrounded by fluid. If during a bi-manual examination the fœtus should chance to lie upon the lower part of the anterior uterine wall, the fingers, sharply pressed into the anterior fornix, will displace it upwards through the amniotic fluid, and the sensation of its disappearance will be felt ; if the fingers are kept in position a slight impact may be felt a moment later, indicating its return to its original position. The return is often missed, but the displacement of the fœtus can frequently be detected. The fœtus, however, often occupies a position where it is out of reach of the fingers on vaginal examination, and this sign cannot then be elicited. It is more easily obtained in the erect than in the supine position. It will be remembered that at this period the size of the fœtus is small in comparison with that of the uterus.

Pregnancy at the sixteenth week can therefore be diagnosed from the following :

Symptoms.	*Signs.*
1. Amenorrhœa.	1. Active breast changes.
2. Quickening.	2. Linea nigra ; elastic hypogastric swelling (uterus).
3. History of recent morning sickness.	3. Cervix softened.
	4. Uterine contractions, internal ballottement.

II. **Diagnosis of Pregnancy during the Second Half.—Symptoms.**—The symptoms during the second half of pregnancy are of little diagnostic importance, since unmistakable evidence is furnished by the physical signs. Amenorrhœa continues ; a good deal of mammary discomfort is often experienced by a primigravida, owing chiefly to the increased weight of the enlarged glands. Towards the end of this period symptoms of increased intra-abdominal pressure appear, such as œdema of the feet and cramps in the lower extremities, varicose veins in the legs and vulva, and sometimes, from upward pressure on the diaphragm, palpitations and dyspnœa. About two to three weeks before the onset of labour these symptoms all undergo a somewhat abrupt amelioration, popularly known as the ' lightening ' ; this is due to descent of the presenting part of the fœtus into the

pelvic brim, and consequent relief of intra-abdominal pressure.

Physical Signs.—*Twenty-sixth Week* (*end of Sixth Calendar Month*).—Hypertrophy of the mammæ is now unmistakable; secretion can be freely expressed; pigmentary areolar changes have become intensified.

Abdomen.—Protuberance of the lower half of the abdomen is now clearly visible, and a few recent striæ may be observed below the level of the umbilicus; the linea nigra in dark women is pronounced. On palpation the fundus of the uterus will be found at the level of the upper border of the umbilicus (Fig. 50). The uterus is distinctly pyriform in shape, and usually extends further to the right than to the left of the mesial plane —*right lateral obliquity*. Occasionally the obliquity is to the left, but the uterus is seldom exactly mesial. Its general consistence is elastic, but it does not yield a fluid thrill. Contractions can usually be felt when it is gently palpated with the hands for two or three minutes. From the period when the fundus becomes palpable above the pubes, it rises, when developing normally, a little less than ½ inch a week.

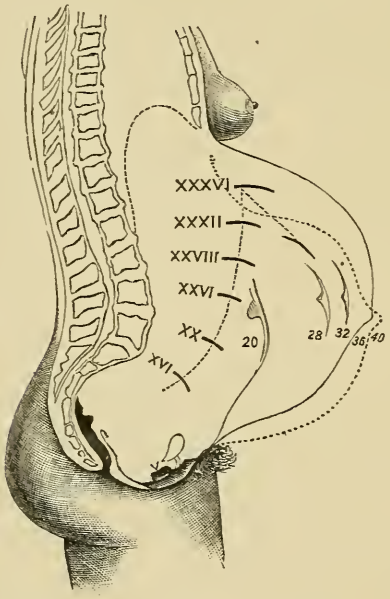


Fig. 50.—Schematic Representation of the Height of the Fundus and the Shape of the Abdomen in Pregnancy. (Roberts.)

The figures indicate weeks.

In addition certain other signs may be detected on abdominal examination which are not found at earlier periods; these are, on palpation, *external ballottement* and *spontaneous fœtal movements;* and on auscultation the

uterine souffle and the *fœtal heart-sounds*. Palpation of fœtal movements and auscultation of the fœtal heart are positive or absolute signs of the presence of a living fœtus, and their detection renders the diagnosis of pregnancy not presumptive, but certain.

At the twenty-sixth week, the fœtus, though large enough to be readily felt on abdominal palpation, moves freely, for it is still small in comparison with the size of the uterine cavity. The palms of both hands should be gently laid over the uterus, and while one hand is used to steady it, the fingers of the other hand make a series of quick but gentle impacts upon it ; the whole anterior surface and sides of the uterus are gone over in this way. At some part or other the fingers will come down upon the body or a limb of the fœtus ; the latter immediately recedes before the impact, but gives a distinct momentary sense of contact with a freely movable body. This is called *external ballottement*. Sometimes the fœtus can be displaced in this way across the uterus, and thus, as it were, tossed from one hand to the other. While using the hands in this manner, *spontaneous movement* of some part of the fœtus, probably a limb, will often be detected, proving not only that there is a fœtus present, but that it is alive. Care is required in eliciting these signs, but they are of great diagnostic value. As pregnancy advances the spontaneous movements made by the fœtus become much more manifest, and during the last six or eight weeks they are felt by the mother as energetic and even violent movements from which she is not free for more than a few hours at a time, and which often disturb sleep. Moving freely in its bag of liquor amnii the fœtus thus takes exercise, which is no doubt of importance in the development of the muscular system. The principal movements are made by the limbs, but movements of the trunk also occur resulting in changes of ' position ' and ' presentation ' (see p. 262).

Uterine Souffle.—From the middle of pregnancy onwards, a soft, blowing, systolic murmur, synchronous with the mother's pulse, can usually be heard on auscultation of the gravid uterus. It is best heard at the lowest part of the lateral borders, but may sometimes be loud enough to be audible over a large part of the anterior surface of the uterus. In seeking this sign the uterus should be steadied with one

hand and the stethoscope pressed firmly upon it; while listening to the sound the mother's pulse, with which it is synchronous, should be felt at the wrist. There is some dispute as to the causation of the uterine souffle, but in all probability it is produced in the greatly enlarged uterine arteries, which, it will be remembered, reach the lateral borders of the organ from the broad ligaments at the level of the internal os. Some authorities believe that it is produced in the large maternal vessels of the placental site and that, accordingly, the part of the uterus over which the sound is loudest is to be regarded as the placental site. Apart from pregnancy, it may be heard in cases of fibroid tumours of the uterus.

Fœtal Heart.—The recognition of the sounds of the fœtal heart is the most conclusive of all the signs of pregnancy; not only is it important in diagnosis, but during labour it affords valuable information, and the student should lose no opportunity of becoming familiar with it. The fœtal heart can usually be heard by the twenty-sixth week, but the further pregnancy advances beyond this, the more easily it is detected. Its localisation at this period is variable, and the whole anterior surface of the uterus must often be carefully searched before it can be found. Some experience in auscultation is of course necessary; but if opportunities of learning this sign in pregnant women at term have been previously made use of, its recognition at this period of pregnancy will be greatly facilitated. At the sixth month the fœtal heart-sounds resemble the feeble or distant ticking of a watch; they are much more rapid than the beats of the mother's pulse, which should always be simultaneously counted as a control, and they differ absolutely in character from the uterine souffle. When for any reason the maternal pulse rate is above 100 it is essential that a definite difference in rate between the maternal pulse and what is taken for the fœtal heart should be clearly made out, for sounds may be transmitted from the aorta which will be misunderstood unless this precaution be taken. At the sixth month the fœtal heart beats from 140 to 160 times a minute, and it is therefore difficult to count. *At term* the average rate is from 120 to 140, but even wider limits than these are possible; only when the rate falls below 100, or rises above 160, can

it be said to indicate danger to the fœtus. The fœtal heart-rate is not a reliable indication of sex. It has been generally believed that the weight of the fœtus affects the heart-rate, and that the larger the fœtus the slower is the rate ; but recent observations by Fieux show that there is no definite relation between weight and pulse-rate.

In connection with the fœtal heart-sounds the *funic souffle* must be mentioned. It sometimes happens in auscultating the gravid uterus that a loop of the umbilical cord lies immediately beneath the bell of the stethoscope, and being subjected to slight compression, either by its position in the uterus or by the instrument, a faint, rapid, blowing murmur is produced, which is synchronous with the fœtal heart-sounds. It is seldom detected, and, as it requires accidentally favourable circumstances for its production, it is of no practical importance.

The *vaginal walls* at this period are distinctly softened ; blue discoloration and softening of the cervix are more distinctly recognisable than at earlier periods. Since abdominal examination yields positive signs of pregnancy, from this period onwards vaginal examination is unimportant for purposes of diagnosis.

Thirty-sixth week.—The shape of the abdomen and the size of the uterus are indicated in Fig. 50. The individual parts of the body of the fœtus can now be recognised by abdominal palpation, and the position of the head, back, and limbs localised. This, however, is of little importance in the diagnosis of *pregnancy,* but attention will be again directed to it in the section dealing with labour (see p. 342). About the thirty-sixth week the uterus attains its greatest height in the abdomen, extending nearly to the xiphoid cartilage, and the maximum abdominal girth averages 32 inches ; during the last fortnight of pregnancy it may sink to a point midway between the umbilicus and the xiphoid cartilage, and the shape of the abdomen is in consequence a little altered (Fig. 50). Numerous recent striæ are found below the umbilicus, which is now flat or slightly everted.

Determination of the Period to which Pregnancy has Advanced.—This is sometimes a matter of considerable difficulty, yet its practical importance is great. The most reliable guide is the calculation of the interval which has

elapsed since the last menstrual period. Where these data cannot be obtained the date at which quickening occurred may be obtainable, and this may be taken as about the sixteenth week. In the absence of both these guides the height of the uterus above the pubes is the only other criterion of calculation. This is necessarily inexact and variable, and in estimating pregnancy by this method there are several obvious sources of fallacy to be borne in mind. Thus there are individual differences in the thickness of the abdominal parietes, the amount of liquor amnii, the size of the fœtus, and the stature of the mother. The size of the uterus is dependent to a great extent upon the amount of liquor amnii which is present; deficiency is associated with an unduly small, excess with an unduly large uterus. In twin pregnancy the uterus is also unduly large. Certain conditions make the uterus *apparently* larger than it should be ; thus contraction of the pelvis may prevent the fœtus from sinking into the pelvic brim towards the end of pregnancy, and so occasion an increased height of the uterus ; a tumour lying in the pelvis would produce a similar effect. The most useful rule is that worked out by Macdonald, who found that after the twenty-sixth week the height of the fundus above the symphysis in centimetres, divided by 3·5, gives the number of *lunar* months of pregnancy. Thus, if the height is 30 cm. (12 inches), the period of pregnancy is eight and a half months = thirty-four weeks.

Differential Diagnosis of Pregnancy.—To consider all the varieties of abdominal swellings which may be mistaken for a pregnant uterus would require a wide excursion into the domain of gynæcology, and cannot be undertaken here. It is, however, necessary to recall the occasional occurrence of a curious imitation of pregnancy of hysterical origin which is known as *Pseudocyesis* (spurious pregnancy). It occurs in women of neurotic temperament, especially when associated with either dread of pregnancy, as in the unmarried, or desire to become pregnant, as in sterile married women. Such women present the symptoms of amenorrhœa, morning sickness, and progressive abdominal enlargement ; they quicken, and feel what they regard as continual and active fœtal movements ; and at the appointed time they suffer from severe

and prolonged abdominal pains which they are convinced represent labour, but which of course have no result. On physical examination certain signs of mammary activity may be found, which are undoubtedly deceptive. The abdominal enlargement, however, will seldom deceive any but the most inexperienced practitioner ; none of the positive signs of pregnancy can be detected either by abdominal or vaginal examination ; and if an anæsthetic is administered the abdomen becomes flattened (unless the patient is very obese), and bi-manual examination will demonstrate that the uterus is not enlarged.

Multiple Pregnancy

While it is the rule in the human species for only one child to be born at a birth, twin pregnancy occurs in the proportion of about 1–80 to 1–90 births ; but its frequency varies greatly in different countries. Heredity is the only known factor in causation, and the influence of this factor is very marked. Triplets are very much less frequent than twins, and are estimated to occur only once in 6,000 to 10,000 pregnancies. Quadruplets are still less common ; although they may reach the period of viability and be born alive, they seldom all survive. Quintuple pregnancy is extremely rare, and always ends in abortion. A recent instance has been recorded by Nijhoff, who in addition succeeded in collecting twenty-seven recorded cases of quintuplets in obstetrical literature between 1694 and 1900, which sufficiently indicates the great rarity of the condition.

Twin Pregnancy may result from the simultaneous fertilisation of two ova, or from the fertilisation of a single ovum; the former are called *binovular*, the latter *uniovular* twins. *Binovular* twins may result from the fertilisation of an ovum from two distinct Graafian follicles, or of two ova from a single follicle. Sometimes two follicles ripen simultaneously in one ovary. The ova may both develop in the normal uterus, or one in each half of a double uterus ; or one in the uterus, the other in a Fallopian tube ; or one in each Fallopian tube. They are much more frequent than uniovular twins, the proportion being about 6 to 1. We can only speculate upon the manner in which *uniovular* twins are produced.

The ovum may possess two germinal vesicles (nuclei) ; or two embryonic areas may be formed if an ovum is fertilised by more than one spermatozoon ; or the single embryonic area may divide, each half producing a fœtus. Differences between binovular and uniovular twins are to be found in sex, in development, and in the formation of the placenta and membranes. In each variety hydramnios of one ovum may occur, the other remaining normal.

Sex.—Uniovular twins are always of the same sex ; binovular twins may be of the same or of different sex, the latter being rather more common than the former. Therefore twins

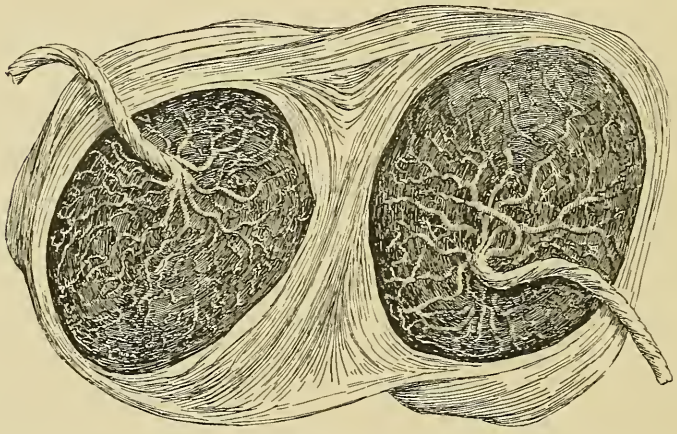


Fig. 51.—Twin Placentæ and Membranes of Binovular Development. (Ribemont-Dessaignes and Lepage.)

of the same sex may be developed either from one or two ova, while those of different sex are necessarily binovular. Including all cases, twins are more commonly of the same sex (boy and boy, or girl and girl) than of different sex, and as in single pregnancy the number of boys exceeds that of girls.

Development.—A twin fœtus is usually somewhat smaller and lighter than a single fœtus ; the two are frequently unequal in size, and differences of 1 to 1½ pounds in weight are not uncommon. One may be normally developed, the other malformed ; or one may perish during pregnancy while the other develops till term. Malformations are common with uniovular twins, and certain rare forms of monstrosity only

occur in such fœtuses. *Placenta and Membranes*.—With *binovular* twins the two ova may develop quite separately from one another, so that two separate placentæ and two complete sets of membranes are formed (Fig. 51). If, however, the two ova should be implanted close to one another in the uterus, the two placentæ will be in contact, and they may even become more or less firmly united by their adjacent edges, forming apparently a single organ. The decidua capsularis then forms a single envelope for the two ova, so that the two chorions are apposed where the ova come in contact. The circulatory system of each fœtus is quite

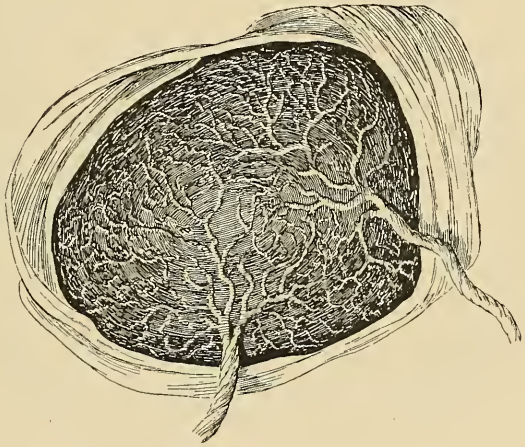


Fig. 52.—Twin Placentæ and Membranes of Uniovular Development. (Ribemont-Dessaignes and Lepage.)

distinct, even when the placentæ are thus united ; anastomoses never occur. With *uniovular* twins a single placenta and chorion are formed ; the amnion may be double (Fig. 53) or single (Fig. 52), the septum in the former being frequently incomplete at term. Usually the umbilical cords are distinct ; sometimes the cord is single at its placental insertion, but bifurcates before reaching the fœtuses. Free anastomoses always exist in the placenta between the circulatory systems of the two fœtuses, and according to Schatz this is usually arterial, but may rarely be venous ; venous anastomoses (placental) are superficial, arterial anastomoses are deep. As a result of these anastomoses

blood from one fœtus finds its way into the circulation of the other—an important factor in the production of certain fœtal monstrosities. One fœtus may also have at its disposal a larger placental area than the other, the one thus favoured being always the more fully grown. Such mon-

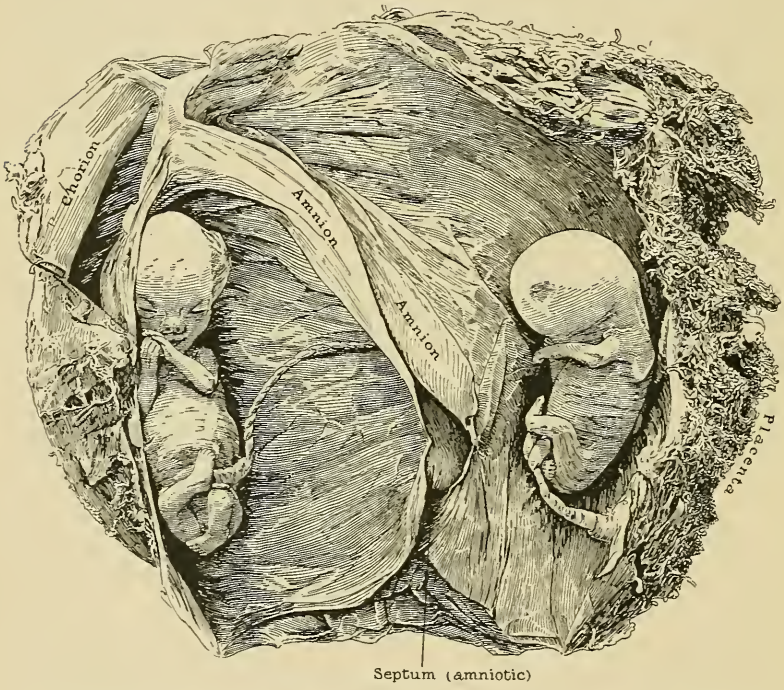


Fig. 53.—Twin Pregnancy (probably Uniovular); Abortion at Third to Fourth Month. The Amnion is double. (Charing Cross Hospital Museum.)

Note that torsion has occurred in the umbilical cords.

strosities as the thoracopagus are only possible in twins of uniovular development.

Recent observations upon the development of the amnion make it probable that twin fœtuses with a single amnion or with united umbilical cords are developed by division of an originally single embryonic area, for the amniotic vesicle is clearly seen at a time when the embryonic area is represented merely by a thickened layer of ectodermal cells.

Superfecundation and Superfœtation.—If two ova are

fertilised simultaneously, twin pregnancy results; sometimes a second ovum is fertilised while the first is developing, and to this condition the above terms are applied. If the interval between the two separate acts of fertilisation is a short one, the condition is called *superfecundation;* instances are well known to occur in lower animals, as when, for example, a mare gives birth to a horse and a mule at a single labour, having been covered at about the same time by a stallion and an ass. Proof of its occurrence is difficult in the human subject, and unless the fœtuses are of different colour it is indistinguishable from binovular twin pregnancy. When the interval between the two acts of fertilisation is considerable, amounting to weeks or even months, the condition is called *superfœtation.* If ovulation continues during early pregnancy, there is no insuperable obstacle to the fertilisation of a second ovum and its lodgment in the uterine cavity, so long as the decidual space persists—*i.e.*, up to the fourth month. The result of this occurrence would be the presence in the uterus of two fœtuses of different stages of development. It is easy to conceive of such an occurrence in the Fallopian tubes or at any period of pregnancy in a double uterus. Superfœtation may end in abortion, both ova being thrown off before they are viable; or one ovum developing to full time, a mature fœtus and a premature one may be born at the same labour; or the birth of a mature fœtus may be followed after an interval of a few weeks by the birth of a second equally mature.

Clinical Course of Twin Pregnancy.—Diagnosis is impossible during the early months; it can only be established by the detection in the uterus of two fœtuses. The uterus is always larger than normal, but undue enlargement must not be attributed to twins without more definite evidence. The surest sign is the recognition of two distinct fœtal hearts, beating at different rates. This sign cannot be detected until after the sixth month, and unusual care must be exercised in establishing the difference in rate between the two hearts. It is not sufficient for the observer to find fœtal heart-sounds audible at two different parts of the uterus, for rapid changes in the position of the fœtus may occur, and thus lead to mistakes. Two observers auscultating at the same moment should simultaneously count the

fœtal heart-sounds to which they are listening, and if a definite difference of, say, ten beats per minute is detected between them, twins may safely be diagnosed. This difference in rate is believed to depend upon inequality in size of the fœtuses ; but if there is only slight inequality there will be no recognisable difference in rate. Towards the end of pregnancy the presence of a fœtal head may sometimes be definitely recognised both at the fundus and in the lower uterine segment. Twin pregnancy is frequently complicated with hydramnios, and this condition greatly increases the difficulty of diagnosis by obscuring the results both of palpation and auscultation.

Fig. 54.—Mummified Fœtus (Fœtus papyraceus).
(Charing Cross Hospital Museum.)

Twin pregnancy usually ends a little before term ; that is to say, labour is premature. Owing to the undue size of the uterus, pressure symptoms may be unusually troublesome, and morning sickness is said to be often unusually severe. Sometimes the uterus is not much larger than normal ; this may be due to the fact that one fœtus has perished *in utero*. When this occurs the fluid in the dead ovum is absorbed, and the body of the fœtus compressed between the growing ovum and the uterine wall, and its tissues altered by absorption of fluid ; the result is the birth of a curiously flattened mummified fœtus, to which the term *fœtus papyraceus* or *fœtus compressus* has been applied

(Fig. 54). The placenta of this fœtus offers a striking contrast with that of the living one ; it is pale, and completely consolidated on section, no trace of the normal spongy tissue remaining. Microscopically it presents the appearances characteristic of advanced infarction and fatty degeneration.

Triplets result from the fertilisation of three separate ova or from the occurrence of uniovular twins with an ordinary

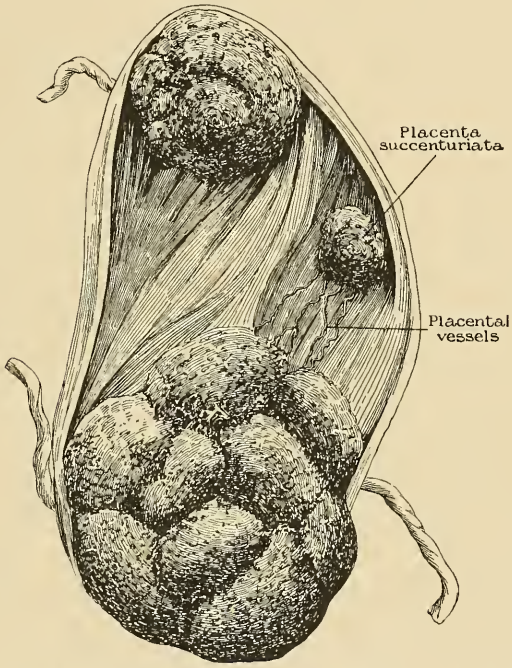


Fig. 55.—Triplet Placenta developed from Two Ova, and showing the Abnormality of Placenta succenturiata. (Ribemont-Dessaignes and Lepage.)

single fœtus. In the former case three distinct placentæ and sets of membranes are found ; in the latter and commoner case there are two placentæ of very unequal size, the larger having two cords attached, and corresponding to the placenta of uniovular twins (Fig. 55). The single fœtus may have a distinct set of membranes. Triplets are more commonly of different sex than all of the same sex, but boys predominate considerably in number. Diagnosis is very difficult, and

labour usually comes on prematurely. The survival of all three infants is rare.

The Management of Normal Pregnancy

Although pregnancy is a normal bodily function, and should not be regarded as a malady, it is undoubtedly attended by many risks, and it involves a considerable strain upon certain organs, which they may be unable to bear unless care is taken to maintain them in a condition of normal physiological activity. This is especially the case in a first pregnancy ; afterwards the organism appears to be able to bear with less disturbance the altered conditions involved in the pregnant state. The functions which require the closest attention are those of digestion and excretion, for their failure may involve the most serious consequences both to the mother and the child. Diet is a matter of some importance during pregnancy. Generally speaking the appetite is increased above what is normal to the individual, and over-feeding is not called for when the conditions are normal. Dietetic fancies quite foreign to the normal tastes of the individual are sometimes met with, the so-called ' longings,' and these need not be discouraged if the direction they take is not unwholesome. Food should be simple and plainly cooked ; meat should be taken only in moderate quantities, and sugar or sugar-containing foods should be reduced even more than animal proteids. Fluids should be taken freely, and the value of milk in such a diet is sufficiently obvious. Alkaline natural waters, such as those of Vichy or Contrexéville, are useful. The waste of phosphates and chlorides which occurs during pregnancy should be borne in mind, and lime salts in the form of phosphates or glycerophosphates are useful. The tendency to anæmia must not be lost sight of, and administration of iron is especially useful in the early months. Exercise is necessary, but should not be violent or attended by risk of accident, which may result in abortion. The more energetic forms of outdoor exercise should therefore be avoided, but walking is useful at all periods. If for any reason exercise cannot be taken, daily massage of the limbs and back forms a useful substitute for it.

Few, if any, of the ordinary symptoms of pregnancy

require treatment. If morning sickness is troublesome the patient should take her first meal before rising, preceded by a mild aperient, such as a seidlitz powder, or a dose of Apenta water. If nausea continues during the day, alkaline remedies, such as the salts of bismuth, soda, and magnesia, are useful. During the later months pressure-symptoms are often much relieved by wearing a well-fitting abdominal belt. The urine should always be examined at least once in the first three months, and a regular monthly analysis should be made during the second half of pregnancy, on account of the liability to the appearance of albuminuria at this time. This is of especial importance in a primigravida. Success in treating this serious complication depends entirely upon its early recognition.

Examination of the gravid uterus during the early months of pregnancy is unnecessary, and should be avoided unless required for purposes of diagnosis. It should then be made with care and gentleness, for a rough internal examination may cause a miscarriage. When the examination is made under anæsthesia there is especial need for caution, as an undue amount of force may then unconsciously be used, in the absence of any check from the sensations of the patient. A complete physical examination should, however, always be made at about the thirtieth week to determine (1) the presentation and position of the child ; (2) the relation between the size of the head and that of the pelvic brim ; (3) the condition of the bony and soft maternal passages ; (4) the presence and rate of the fœtal heart-sounds. The importance of determining these points well in advance of term will be made clear in the section dealing with the management of labour. The examination of presentation and position should be repeated two or three weeks before labour is due.

During the latter half of pregnancy the nipples must be prepared for suckling in the manner described on p. 561.

Part II

ABNORMAL PREGNANCY

Although pregnancy is not a disease, but a normal function of the body, there is no doubt that a pregnant woman is exposed to many serious risks which are peculiar to her condition, while certain maladies to which all women are liable are of increased gravity when associated with the pregnant state. In addition, morbid conditions primarily affecting the ovum, are met with which destroy it and lead to its premature expulsion. The pathology of pregnancy thus assumes very large proportions, and comes to embrace a great number of morbid conditions which may affect the mother, the embryo, or the fœtus and its appendages. In order to make the subject intelligible, and capable of being dealt with briefly, classification is required, but a practical classification is by no means easy to devise. A simple division into the main groups is, however, easily made ; for while some of the conditions included are abnormal developments of pregnancy, *i.e.*, conditions necessarily associated with the pregnant state, in the case of others the association with pregnancy is only accidental. The first group we may call The Disorders of Pregnancy, for pregnancy is the essential factor in their causation. As examples may be mentioned the disease called *eclampsia*, and the *hydatidiform mole* (vesicular degeneration of the chorion) ; none but pregnant women suffer from these diseases and their many consequences, and they are directly due to some disturbance of the normal course of pregnancy. The second group we may call The Disorders associated with Pregnancy ; they may have been in existence before conception occurred and have become aggravated by pregnancy, such as *valvular disease of the heart ;* or they may arise during the course of pregnancy and interrupt it, like the *acute eruptive fevers.* Instead of subdividing the first group into *fœtal* and *maternal*

disorders, as is usually done, we shall classify them as follows :

I. Disorders of Pregnancy

Toxæmias.

(1) Albuminuria and Eclampsia.
(2) Pernicious vomiting.
(3) Ptyalism.*
(4) Pruritus.*
(5) Herpes.*
(6) Mental disturbances.*

Abnormal Conditions of the Gravid Uterus.

(1) Displacements.
(2) Malformations.

Pressure-symptoms.

(1) Œdema.
(2) Varicose veins.
(3) Hæmorrhoids.

Abnormal Conditions of the Ovum.

(1) *The Early Ovum.*

(*a*) Moles.
i. Blood mole—Fleshy mole (hæmatoma mole).
ii. Hydatidiform mole (vesicular degeneration of chorion).
(*b*) Decidual endometritis.

(2) *Placenta and Membranes.*

(*a*) Oligo-hydramnios.
(*b*) Poly-hydramnios.
(*c*) Placental diseases.
Œdema.
Fatty degeneration.
Hæmorrhage.
New-growths.
Syphilis.
Tubercle.
Infarction.

Abnormal Implantation of the Ovum.

Ectopic gestation.

* Provisionally classed as toxæmias.

II. Disorders associated with Pregnancy

(*a*) Acute eruptive fevers.
(*b*) Syphilis and tubercle.
(*c*) Cardiac disease.
(*d*) Renal disease.
Bright's disease ; bacillus coli infection.
(*e*) Hepatic disease.
Acute yellow atrophy ; diabetes.
(*f*) Diseases of the nervous system.
Chorea.
(*g*) Pelvic diseases.
Ovarian and uterine tumours.
Gonorrhœa.

Toxæmias of Pregnancy.

Before proceeding to consider individually the disorders which are included in this group, there are certain general considerations applicable to them all which must be referred to. Thus we must first consider what reasons we have for regarding them as toxæmic in origin, and also what is known or surmised as to the nature and source of the toxæmia.

As regards the first point, it must be said at once that direct proof of their toxæmic origin cannot be advanced, and is in the nature of the case practicable only by the actual discovery of the toxic body or group of bodies. Nevertheless a mass of evidence based upon the analogy of other diseases known to be toxæmic, and upon scientific inference, has been gradually accumulated, which for practical purposes amounts to proof. Post-mortem changes naturally furnish a great part of the evidence required, and consequently those diseases which tend to terminate fatally supply the best opportunities for studying the toxæmias of pregnancy. Proof of their toxæmic origin is accordingly much more complete in the case of eclampsia and pernicious vomiting than any of the others, all of which show little tendency to cause death.

The *post-mortem changes* believed to be characteristic of death from toxæmia will be fully described in connection with eclampsia. It may be stated here that they consist mainly of two groups ; (*a*) extensive thrombosis, and interstitial hæmorrhage from rupture of capillaries ; (*b*) cell

necrosis, sometimes scattered, sometimes affecting large areas, *i.e.*, '*massive necrosis*.' These changes are widely distributed, and while the liver and the kidneys are the organs mainly affected, to a less extent they may often be found in many others.

In addition to the post-mortem changes certain clinical evidences of toxæmia may also be forthcoming. One of the most important is to be found in modifications of nitrogen metabolism and of carbohydrate metabolism.

In health the *urinary* excretion of *nitrogen* takes place through the following substances (Folin) :

Urea	. . . . .	87·0 per cent.	of the total urinary N.
Ammonia	. . . .	3·3 ,,	,, ,,
Creatinin	. . . . .	2·7 ,,	,, ,,
Uric Acid	. . . .	0·7 ,,	,, ,,
Undetermined Nitrogen	. .	6·0 ,,	,, ,,

In toxæmic conditions the proportions of these substances are substantially modified ; the amount excreted as urea is diminished, while the amount excreted as ammonia, and as ' undetermined ' is considerably increased. Three per cent. is the normal ammonia-coefficient of N excretion ; a rise in this coefficient is an indication of toxæmia. The analyses required to determine these changes are elaborate and costly, and accordingly the determination of the ammonia-coefficient has not been widely made use of except by expert pathological chemists. But sufficient work has been done to show that in eclampsia and in pernicious vomiting a rise in the ammonia-coefficient is usually found, and that in severe cases it may reach 20 per cent.

There are certain sources of fallacy which must be guarded against in applying the test ; thus severe vomiting and restriction of diet both occasion a moderate rise in the NH_3 coefficient, probably because ' starvation ' of the tissues results in an excessive production of tissue-waste products, the resulting ' toxæmic ' condition being aggravated by the coincident failure of the excretory functions. Within recognised limits, however, the test is a useful one.

Carbohydrate metabolism is also profoundly affected in toxæmia, especially in those forms which are associated with persistent vomiting. This is shown by the accumulation in

the blood of two acid substances, viz., diacetic acid and β-oxybutyric acid; along with them acetone is also always found, but the presence of that body alone is not of great clinical significance. When present in the blood in great excess these substances constitute the condition known as 'Acidosis,' one of the most dangerous toxæmic conditions with which we are acquainted. It has been shown that in severe cases of eclampsia and also of pernicious vomiting a condition of acidosis usually exists; it is also believed to be the cause of diabetic coma, and is present in post-anæsthetic chloroform poisoning such as sometimes occurs after prolonged anæsthesia.

In all probability there is a direct connection between acidosis and an increased ammonia-coefficient. The excess of acid in the blood is partly neutralised by the alkaline salts of the blood serum; the alkaline base of the blood salts is mainly ammonia, and the resulting compounds of ammonia with diacetic acid and oxybutyric acid, being excreted through the kidneys, tend to raise the ammonia-coefficient.

The organ chiefly concerned in carbohydrate metabolism, and in the final stages of N metabolism, when the innocuous end-products, such as urea, are produced, is the liver. It therefore appears that derangement of the liver functions plays an important part in the production of toxæmia.

Another point in which pregnancy toxæmia comes into line with toxæmic conditions generally is that there is a considerable increase of *lipoid substances* in the blood, which is probably to be regarded as another indication of derangement of the hepatic functions.

Still further clinical evidences of a toxæmic state are to be found in elevation of blood pressure, fever, diminution of the excretory functions, and the supervention in the final stages of coma, with or without convulsions. Occasionally hæmorrhages from mucous surfaces occur, and in rare instances serious bleeding from the gastric and intestinal mucous membranes have been observed. All of these symptoms may appear in serious examples of pregnancy toxæmias.

The Nature of the Toxic Bodies.—Long before the modern theory of toxæmia was foreshadowed, clinical observers had thrown out the suggestion that certain of the diseases

peculiar to the pregnant state might, perhaps, be due to the undue accumulation of waste products in the maternal blood derived from the body of the fœtus, and coming through the umbilical vessels. They imagined an adjustment, under normal conditions, of the eliminatory functions to enable them to cope with the increased output of waste products necessitated by the development of the child in the uterus. This adjustment might conceivably break down, either from excessive maternal absorption of waste products resulting from fœtal disease, or from deficient elimination produced by functional or structural changes in the great maternal organs of excretion. Recent biological research has not lent support to the theory of fœtal intoxication as conceived by clinical observers of an earlier time. Further, it has been shown that toxæmia of the gravest kind may occur in association with the vesicular mole (p. 148), in which there is usually no fœtus, and consequently fœtal metabolism can play no part.

Recent work has postulated two possible sources of toxæmia in pregnancy, a *maternal* and a *chorionic* or *placental*.

The *maternal* theory may be stated as follows. In health the waste products of the body tissues are disposed of either by direct excretion through the kidneys, skin, and intestines, or by transformation into harmless substances within the body ; the organ mainly concerned in the latter process is the liver, with perhaps, secondarily, certain ductless glands such as the spleen, the thyroid, and the suprarenal bodies. In normal pregnancy, although an excess of waste products may enter the maternal blood from the uterus and ovum, the normal channels of excretion and transformation suffice for their removal, although evidences of derangement of the functions of the liver in normal pregnancy have been already adduced. In addition, indications are not wanting that certain definite alterations in the general metabolism of the body also occur during pregnancy ; although their significance is not at present clear, they must be regarded as important in respect to the delicate balance of the functions of ingestion and elimination. In order to maintain in pregnancy the normal equilibrium, it is clearly necessary that all the maternal organs concerned should maintain their functional activity, and even perhaps increase it above the

normal level. A physiological breakdown on the part of important organs like the liver or kidneys must necessarily entail serious consequences—much more serious than in the non-gravid state—and accumulation of toxic waste products of maternal origin in the blood will become inevitable. The organs which most commonly show clinical signs of failure during pregnancy are the kidneys, and this failure, as we shall see, is probably accompanied by certain pathological changes in the renal cortex. But the view that the kidneys are the organs primarily at fault cannot be maintained ; the changes in them are the result of profound biochemical disturbances of metabolism, the primary cause of which may finally prove to be different in different morbid conditions.

The maternal theory thus regards pregnancy toxæmia as an auto-intoxication due to a breakdown of general metabolism ; one of the first results of this auto-intoxication is that renal changes occur which profoundly affect urinary excretion, and thus aggravate the toxæmic condition.

The *chorionic* or *placental* theory goes much further than this, and attempts to indicate the actual source of the toxic bodies. The maternal organism, according to this view, is directly poisoned by certain elements of the ovum. These are not the waste products of the body of the fœtus, but are derived from the fœtal membranes. The parasitic, toxic nature of the portions of chorionic epithelium which under normal conditions are detached and enter the maternal blood is held to be proved by Abderhalden's test. Toxæmia may conceivably result from a failure of the antibodies to deal effectively with these syncytial masses, and this may be due to the presence of the latter either in abnormal quantity or in altered quality.

The entrance of syncytium into the maternal blood is mainly found in the early months, when the syncytium is most active ; in the later months it is much less marked. Schmorl and others have, however, shown that in eclampsia pulmonary emboli containing small chorionic villi and masses of syncytium are not uncommonly found. It is, therefore, possible that this disease is accompanied by a renewed active penetration of maternal vessels by the syncytium, and to this extent, in the case of eclampsia, post-mortem conditions lend support to the placental theory.

Direct intoxication by the accumulation of syncytium in the blood is not the only form in which the placental theory may be stated. It is possible that complex toxic bodies may be secreted in the placenta and passed thence into the maternal circulation. Many attempts have been made to separate such toxic bodies from the placenta, both in health and in disease, but no conclusive results have been obtained. There is, therefore, no actual proof that the placenta can elaborate toxins. Interesting observations bearing upon this point have, however, been recently made by James Young. This observer claims to have shown that if a placental cotyledon becomes separated from the uterine wall by hæmorrhage, massive necrosis of the separated cotyledon ensues; the resulting products of placental autolysis will freely enter the maternal blood, and he suggests that such a mass of necrotic tissue may become the source of toxic bodies capable of producing either eclampsia, or other forms of pregnancy toxæmia. This view implies that retro-placental or retro-ovular hæmorrhage causing extensive placental chorionic necrosis is the primary cause of the toxæmia, and therefore, without it, toxæmia will not occur. Young's observations were confined to cases of eclampsia, and can be easily tested by the systematic examination of eclamptic placentæ.

While in the meantime no definite conclusion can be reached, it must be said that the weight of evidence is strongly in favour of the theory of the placental (chorionic) origin of pregnancy toxæmias. In the case of eclampsia the evidence is stronger than in the case of any of the other toxæmias.

Albuminuria and Eclampsia

Albuminuria occurring during pregnancy may be due to (1) *pre-existing renal disease—e.g.*, chronic nephritis; (2) *pregnancy*. The latter is spoken of as 'the albuminuria of pregnancy,' and must be sharply distinguished from the former variety, which will be considered in the group of 'Disorders associated with Pregnancy.' Albuminuria and eclampsia must be considered together because, although eclampsia may very exceptionally occur without albuminuria,

they are almost invariably associated. This association is indeed so marked that the conclusion cannot be avoided that they are due to one and the same cause. It must, however, always be borne in mind that the majority of cases of albuminuria terminate favourably without the supervention of eclampsia ; further, it cannot be said that the higher the degree of albuminuria the greater is the risk of eclampsia.

Strictly speaking, albuminuria is but a symptom, and in the disease which is conveniently designated ' the albuminuria of pregnancy ' other clinical features of great importance are found besides the presence of albumen in the urine. We must be careful, therefore, to exclude, in addition to pre-existing renal disease, such transient causes of albuminuria, as fatigue and dyspepsia, which may give rise to it temporarily in any circumstances. Albumen due to these causes only occurs in traces. Contradictory statistics have been published as to the frequency with which albuminuria is to be found in pregnant women, the proportion varying, according to different observers, from 3 to 50 per cent. The highest rate of frequency occurs in parturient women, and there is no doubt that in a large majority of primiparæ, and in a smaller proportion of multiparæ, traces of albumen occur in the urine during normal labour, and disappear at once when labour is over. This condition does not concern us at present but will be referred to again later on. Excluding parturition, the rate of frequency of albuminuria in pregnant women probably does not exceed 3 to 5 per cent., and from this must still be deducted cases of pre-existing renal disease and cases of transient functional albuminuria. It will therefore be seen that the disease we are considering is fairly uncommon.

Clinical Features.—The albuminuria of pregnancy is practically confined to the latter half of the period of gestation, and seldom manifests itself earlier than the sixth month (twenty-sixth week), although cases of eclampsia at the fifth month have been recorded. It is much more frequent in primigravidæ than in multiparæ. Cases differ greatly in severity : in some the only symptom is a moderate amount of albumen in the urine, which disappears under treatment ; or, even when persisting, it may be unaccompanied by other symptoms, and may not interrupt the development of the

ovum or the course of the pregnancy. Every case, however, requires careful management, for the risk of other and more serious symptoms supervening is always present. Thus albuminuria is frequently accompanied by other urinary changes, and by anæmia and anasarca ; frequently it leads to death of the fœtus *in utero* and the occurrence of premature labour ; more rarely it leads to the occurrence of retinitis, or terminates in convulsions (*eclampsia*). These conditions must now be considered in more detail.

Urinary Changes.—In the earlier stages of the affection the urine is abundant, pale, of low specific gravity, and contains a diminished proportion of total solids. The amount of albumen present is a rough indication of the severity of the case. There may be but a trace ; usually, however, the amount is considerable ($\frac{1}{10}$ to $\frac{1}{6}$ per cent., Esbach), and in the worst cases of all—viz., those which terminate in eclampsia—the urine, when tested during the eclamptic seizures, usually solidifies on boiling. The amount of albumen is not in itself a reliable index of the *liability to eclampsia*, for many cases with a heavy albumen output terminate without convulsions. It has been observed that a large proportion of the albumen is serum globulin, but we do not know the significance of this point, and, owing to technical difficulties in estimation, the exact proportion of globulin to albumen has not been worked out in a series of cases. Of more importance is the occurrence of casts which can usually be found ; they are hyaline and granular, and often show fatty degeneration. Red and white blood-corpuscles are also occasionally found. The total amount of urea excreted is fairly normal, but a diminution usually occurs in connection with eclampsia, and a fall in the output of urea is an important premonitory sign of this complication. When anasarca is marked, the amount of urine excreted becomes scanty, while in eclampsia the secretion is very scanty, and may even be suppressed.

Anœmia and Anasarca.—These two conditions are usually associated, and it is rare to find one marked without the other being almost equally so. The pallor of the face and mucous membranes forms one of the most striking features of these cases, and gives rise at once to the suspicion of albuminuria. The anasarca affects chiefly the lower extremities, the vulva, and the abdominal wall ; it is said to occur

also in the face and upper extremities, but with such a distribution the greatest care should be taken to exclude chronic Bright's disease. Clinical experience shows, however, that cases in which extensive œdema occurs rarely develop eclampsia. The pre-eclamptic state is, however, sometimes attended with puffiness of the eyelids. The œdema of the lower extremities may be extreme, and sometimes the labia majora become greatly enlarged, so as to interfere with the dilatation of the vulva during labour. It is said that anasarca may occur to a marked degree without albuminuria, or that it may appear first, but this is unusual.

Death of the Fœtus, and Premature Labour.—A heavy fœtal mortality, probably over 50 per cent., attends the albuminuria of pregnancy. It is largely independent of eclampsia. The fœtus perishes *in utero*, and the ovum is then thrown off, either at once or within a few weeks; amelioration of the general symptoms sometimes follows the death of the fœtus, even when it is retained for some time in the uterus. Often, however, a living premature child is born, but it is usually undersized and feeble, and its chance of surviving is but small. Placental disease is present in a considerable proportion of these cases, and appears to be an important factor in causing the death of the fœtus and in inducing labour prematurely. This disease consists in extensive infarction of the placental substance—a change which will be again referred to later on (see p. 165).

Eclampsia.—We do not know the exact proportion of cases of albuminuria which terminate in eclampsia; it is probably small. But eclampsia is by no means confined to cases in which there has been previous clinical evidence, of longer or shorter duration, of the existence of albuminuria. Eclampsia accompanied by albuminuria may suddenly supervene in pregnant women who have previously been in apparently good health; or eclampsia may sometimes come on in this way with no attendant albuminuria. The convulsions are indistinguishable in their general characters and course from those of uræmia, and the differential diagnosis from the former may present insuperable difficulties. Sometimes eclampsia is ushered in by a definite pre-eclamptic stage, the clinical recognition of which is of great importance (see p. 528). Eclampsia is most commonly met with as a

complication of labour, and the consideration of its clinical features and treatment will therefore be postponed till a later section.

Pathological Anatomy of Eclampsia.—Cases of albuminuria are rarely fatal unless complicated with eclampsia ; the pathology of the albuminuria of pregnancy has therefore been somewhat difficult to elucidate, but abundant evidence

Fig. 56.—Renal Tubules from a Case of Eclampsia ; Numerous Fat Globules occur in the Degenerated Cells. (Hamilton Bell.)

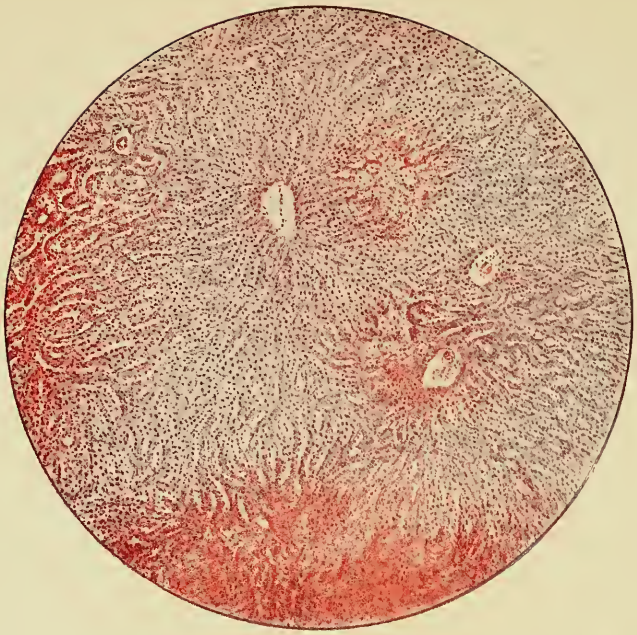
has now been accumulated to show that in fatal cases of eclampsia definite morbid changes occur in the liver and kidneys, and a further series of changes is also found in the spleen, brain and other organs.

Kidneys and Ureters.—Definite renal changes are found in 99 per cent. of autopsies on cases of eclampsia. The most important changes occur in the renal cortex, and they are of the nature of degeneration, not inflammation. The whole kidney is enlarged, the cortex swollen and pale ; the pallor

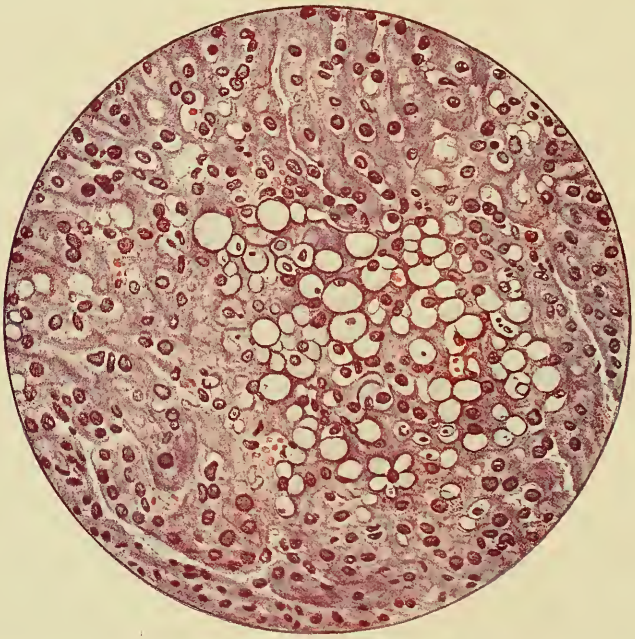
(anæmia) appears to be due to vaso-motor spasm affecting the cortical arterioles. Cloudy swelling with granular and fatty degeneration of the epithelial cells of the convoluted tubules is apparent on microscopical examination (Fig. 56). Small interstitial hæmorrhages and areas of necrosis are also found in the cortex, and thrombosis is often present in the capillaries of the glomeruli. These changes are not universal, but occur in patches, the remainder of the renal substance being healthy. In albuminuria without eclampsia the degenerative changes occur, but not the areas of hæmorrhage and necrosis ; this condition is often called the *pregnancy kidney*. These changes are transient, and, in the great majority of cases that recover, they disappear rapidly after labour, but it is stated that the condition may occasionally pass into true parenchymatous nephritis. The rapid disappearance of the renal changes can of course be watched by observation of the urine during the puerperium.

In a certain proportion of fatal cases of eclampsia, dilatation of one or both ureters above the level at which they cross the pelvic brim has been shown to occur, and some writers have estimated its frequency as one in five. The unfavourable influence of this change upon the functional activity, and even the structure, of the kidney is obvious. It is therefore a factor of importance in the causation of albuminuria, but it must be regarded as a contributory, not an essential, factor. It is most frequently found in primigravidæ, and may be occasioned by the uterus itself, or by direct pressure of the fœtal head upon the ureter ; for we know that in the last two to three months of pregnancy the fœtal head usually occupies the pelvic brim in primiparæ.

Liver.—Changes in this organ are almost invariably found in cases of eclampsia ; they are of great importance and are regarded by some authors as lesions specifically characteristic of this disease. To the naked eye hæmorrhages beneath the capsule and on the cut surface are the most constant feature ; they may be small and numerous, or they may, by fusion, form large areas. The whole organ may be enlarged by the extent of these hæmorrhages ; sometimes it is small and resembles the liver of acute yellow atrophy. On the cut surface areas of ill-defined outline may be seen, paler than the surrounding liver substance,



(*a*) Liver from a Case of Eclampsia. An area of degeneration in the periphery of a lobule is seen in the upper part. An area of total disintegration is seen in the lowest part. In some parts the liver cells are little affected. (Pathology Department of the London Hospital.)



(*b*) Liver from a Case of Toxæmic Vomiting. An area of advanced cell degeneration is seen in the centre ; vacuolation is the chief feature. These changes were widely diffused over the whole organ. (Pathology Department of the London Hospital.)

which, when examined microscopically, appear as areas of massive necrosis.

Microscopically the changes which are found are as follows :—(*a*) Degeneration of hepatic cells, beginning at the periphery of the hepatic lobule and proceeding, in some areas, to total cell destruction (Plate III. *a*). In the early stages the affected cells become cloudy and lose their affinity for stains ; later the cell body becomes disintegrated and breaks down into debris, the nucleus being the last part to persist. (*b*) Interstitial hæmorrhages, either diffused and slight in extent, or forming gross hæmorrhages, with compression or disintegration of the liver substance. Considerable deposits of fibrin are also found. (*c*) Thrombosis of vessels, for the most part those of microscopic size, sometimes affecting large ones. Two kinds of thrombi have been observed, viz., the common fibrinous thrombus, and the non-fibrinous or agglutinative thrombus. The presence of the latter was observed by Flexner and others ; their importance from the standpoint of causation will be referred to below. (*d*) Degenerative changes have been found in the endothelial lining of the capillaries, and to these changes the interstitial hæmorrhages are probably due.

The changes just described usually occur diffused over the whole organ in greater or less degree. In addition blocks of tissue of considerable size may be affected, the so-called ' massive necrosis.' This probably arises from blocking of a vessel of considerable size by thrombosis, which suddenly cuts off the blood supply from the area served by it.

Fatal cases of eclampsia occasionally occur in which little if any morbid changes can be found in the liver.

Spleen.—The spleen is enlarged, congested, and frequently presents hæmorrhages, situated sometimes beneath the capsule, sometimes in the connective-tissue trabeculæ of the organ. Degenerative changes are not marked, as the spleen contains no epithelium, but areas of necrosis may be found.

Brain.—Morbid appearances are found in 90 per cent. of cases ; they consist of small hæmorrhages and scattered areas of necrosis ; in the neighbourhood of the areas of necrosis capillary thrombosis similar to that in the liver is found. Occasionally a large cortical or ventricular hæmor-

rhage is found; five cases of this kind have been collected by Fairbain and Carver.

Heart.—Scattered areas of cloudy degeneration and necrosis also occur in the heart muscle.

Among the rarer changes found in eclampsia may be mentioned necrosis in the pancreas and certain of the endocrinous glands, and embolic infarction of the lungs; the infarcts may contain villi, syncytial masses, and masses of necrotic tissue from the liver. As illustrating the general tendency to hæmorrhage in eclampsia it may be mentioned that gross hæmorrhages are sometimes found apart from the viscera, *e.g.* in the connective tissue of the abdomen.

Fœtus.—It is a significant fact that convulsions may occur in the child born of an eclamptic mother; usually, however, it is born dead. In the liver, changes resembling those in the maternal liver have been met with, and some observers state that they can always be found. Renal changes also occur, but it is difficult to distinguish them from similar changes, not uncommonly found, in fœtuses which die from other causes.

Etiology.—(*a*) *Of the Albuminuria of Pregnancy.*—The changes met with can all be best explained on the assumption that a toxæmic condition precedes them. The immediate cause of the appearance of albumen in the urine is to be found in the degenerative changes in the renal cortex. Anæmia of the cortex from arterial spasm, directly set up by a toxic condition of the blood circulating through the kidneys, is probably the first change. The degenerative changes in the renal epithelium which follow, lead to albuminuria and the formation of casts, and thus the morbid condition of the maternal blood becomes aggravated by the deficient functional activity induced in the kidneys. Dilatation of the ureters, when present, may be a contributory factor in their causation, but the state of the blood is probably the essential factor in all cases. General anæmia and anasarca may also be explained by the toxic condition of the blood; and the same explanation will obviously account for the death of the fœtus *in utero*, through direct intoxication or through the changes induced in the placenta. When eclampsia supervenes, during the course

of albuminuria, it is probable that the morbid condition of the blood steadily increases, gradually inducing changes in the liver, and when the toxæmia reaches a certain height convulsions suddenly come on. In this way the clinical phenomena of albuminuria and of eclampsia may be alike referred to a toxic condition of the blood, which may yield to appropriate treatment, or which may progressively increase until it attains a degree of severity incompatible with life.

(*b*) *Of Eclampsia.*—Although albuminuria and eclampsia are so closely related in sequence to one another they are not absolutely interdependent. Instances of eclampsia occur in which there was no recognisable preliminary stage of albuminuria; the disease supervenes without serious warning in a pregnant woman apparently in good health. In these cases eclampsia and albuminuria appear simultaneously. In other and rarer instances eclampsia may run its course to a fatal ending without albumen being found in the urine at all, and without the characteristic renal changes being developed. The hepatic changes are however, well marked in such cases, and in them the stress of the poisoning appears to fall upon the liver. It is, therefore, probable that the toxic bodies concerned are complex; that some act especially on the kidneys, others on the liver, and that they are present in variable proportions. It may in time prove possible to distinguish two corresponding clinical types of eclampsia, the *renal* and the *hepatic;* in the meantime, however, our knowledge of the correlation of clinical types with post-mortem changes is not sufficient to warrant this.

At the present time we cannot go further than to say that eclampsia is due to a *complex toxæmia*, the constituent factors of which are still to be worked out.

An interesting analogy has been pointed out by Leith Murray, between the pathological changes found in eclampsia and those due to death from snake poisoning. Cobra venom contains five toxic principles, which can be traced by the effects which they produce, viz., (1) thrombotic; (2) hæmolytic; (3) hæmagglutinative; (4) endotheliolytic; (5) neurotoxic. Leith Murray suggests that similar effects can all be traced in cases of eclampsia; (1) fibrinous thrombosis is widespread in the liver; (2) destruction of blood cells occurs; (3) non-fibrinous thrombi are found; (4) degeneration of

capillary endothelium is common; (5) convulsions and coma may be due to direct action of a toxic body upon the higher nerve centres.

This analogy cannot fail to lend support to the toxæmic theory of the causation of this disease.

Reasons have been advanced on a previous page for believing that the chorion is the ultimate source of all pregnancy toxæmias. Eclampsia is a disease which is unknown before the formation of the placenta, with the exception that a few cases have been recorded in connection with vesicular mole. Fully developed chorionic villi are accordingly the source to which we must look for the toxins of eclampsia. Up to the present time attempts to isolate from the placenta of eclampsia toxic bodies capable of reproducing the symptoms in animals have not been convincing, owing to the great technical difficulties involved in the preparation of the material. Until this has been done, actual proof of the placental source of the toxins is lacking. This cannot be held however, to discredit the theory, which is supported by much indirect evidence and which reasonably explains the main features of the disease.

One serious objection to the theory of placental toxæmia must, however, be mentioned, viz., that in a considerable proportion of cases eclampsia begins after labour, during the first few days—first to fourth—of the puerperium (see p. 527). Now clinical observations have shown that rapid improvement in the condition of the kidneys usually follows delivery in cases of albuminuria, and it is believed that the toxic condition of the blood also speedily diminishes. In the cases under consideration we must assume continuance or exacerbation of the toxæmia after labour. This presents great difficulties, since it is the opposite of what usually occurs; but it may be said that these cases are almost equally difficult to explain upon any other theory of eclampsia that has ever been advanced. Clinically they are often severe, and even fatal, and show the post-mortem characters already described.

When it is recollected that the toxæmia of eclampsia is a *complex* condition, the difficulty offered by puerperal cases is diminished. The widespread degenerative changes which have been described in the kidneys, liver, spleen, endocrinous

glands, pancreas, etc., must inevitably lead to such formidable changes in metabolism as to *maintain* a condition of toxæmia, even after the source of the toxic bodies which induced these changes has been eliminated. The failure of the eliminatory functions further aggravates the general conditions. Clinical evidence clearly shows that the alimentary canal is one great channel, probably a vicarious one, for the elimination of the eclamptic toxins. Gastric and intestinal lavage influences favourably the course of the disease, and Tweedy has further shown that the withholding of all stomach food, except water, also exerts a favourable influence. Diminution of the excretion of urine, and the appearance of diacetic acid and β oxy-butyric acid in the blood are not the direct result of the toxins, but are due to the structural organic changes induced by them. Certain of the symptoms of eclampsia, such as high blood pressure, may be due to excitation of the adrenals or pituitary, others such as the rapid pulse, may be due to excitation of the thyroid or parathyroids.

It is, therefore, obvious that when the eclamptic toxins have begun their work their effects will soon be supplemented by other toxins derived from perverted action of viscera of great importance, or from extensive areas of tissue which have undergone necrosis. The widespread changes thus induced may lead to acute toxæmia, even after the absorption of further quantities of the primary poison has been rendered impossible by the removal of the placenta.

If it is admitted that the weight of evidence is in favour of the placenta as the source of the eclamptic toxins, we still do not know how their production is brought about. The suggestion of Young has been already mentioned, viz., that they are the products of autolysis resulting from massive necrosis induced by sudden arrest of the maternal blood supply to a large area of placental tissue. This again may be associated with retro-placental hæmorrhage causing separation from the uterine wall, or extensive thrombosis of the sub-placental sinuses. On the other hand, the toxæmia may conceivably be induced by the passage of syncytial masses in abnormal quantity into the maternal blood. In what manner this could be brought about we do not know.

Only brief mention can be made of the older theories of the causation of eclampsia which have been advanced.

The Uræmic Theory.—This was one of the earliest scientific attempts to explain eclampsia. In its clinical features eclampsia closely resembles uræmia ; but chronic renal disease which is the usual precursor of uræmia, is quite uncommon in cases of eclampsia, and the post-mortem changes are quite different.

The Pressure Theories.—The occasional occurrence of dilatation of the ureter in eclampsia has been already referred to. When this association was first observed, it was regarded as a possible explanation of the disease, the convulsions being regarded as induced by acute dilatation of the ureter and renal pelvis. This theory is disproved by the fact that ureteral pressure is only an occasional accompaniment of the disease. The right ureter is the one usually affected, and direct compression of this duct against the pelvic brim by the gravid uterus or by the fœtal head, is the probable explanation of it.

Compression of the renal veins by the uterus in the last two months of pregnancy has also been suggested as a cause, but there is no evidence whatever in favour of it.

Bacterial infection has also been suggested, but no isolation of an organism has ever been made. In this connection, however, it may be noted that there is a certain amount of evidence that eclampsia may assume an epidemic form ; certainly its occurrence in a series of cases, followed by long intervals of freedom, has been observed in several maternity hospitals.

Treatment of the Albuminuria of Pregnancy.—The early recognition of the occurrence of albuminuria in pregnancy is of great importance both to the mother and the fœtus. Regular examination of the urine every month during the latter half of pregnancy in the case of a primigravida, whether healthy or not, ought to be regarded as indispensable in order to obtain the earliest indication of renal trouble. The presence of albumen is a warning sign that a *state of toxæmia may be present.* Further investigation must then be made in order to decide whether the condition is a toxic albuminuria or not. The importance of treating albuminuria early lies in the fact that such treatment is almost always successful in averting eclampsia, and must be

insisted upon in all cases, whether the patient is obviously ill or not. During the course of the treatment daily estimations of the total urinary secretion and of the output of urea ought also to be made, for a fall in the excretion of urea is an important premonitory sign of eclampsia.

The treatment consists in the main in promoting free action of the various organs of excretion, and regulating diet so as to diminish as far as possible the work thrown upon the digestive organs, especially the liver. Milk should be the staple article of diet, and the patient should take from 3 to 4 pints daily, but except in the worst cases fish and chicken may be added. The diet should be free from salt. Alcohol, meat, and rich food must, of course, be forbidden, and the skin should be kept acting freely by daily sponging. In a severe case the patient should be confined to bed, and the eliminative treatment described on p. 533 carried out either partially or, if necessary, in its entirety. The effect of treatment can easily be watched by systematic examination of the urine, and in a favourable case the amount of albumen will diminish and the casts disappear, while the amount of urea remains satisfactory ; but it will be remembered that upon milk diet the excretion of urea is naturally below normal. The anasarca will usually diminish greatly if the patient is kept in bed. Sometimes a large labial swelling due to œdema is formed, which causes considerable distress ; this may be relieved by puncture with a Southey's tube under careful antiseptic precautions. If the course of the disease cannot be controlled in this way the prognosis is grave ; the fœtus will probably die *in utero ;* or premature labour may come on, with the sacrifice of the life of the child ; or possibly the dreaded complication of eclampsia may supervene.

In all serious cases an ophthalmoscopic examination of the fundus should be made. If retinal hæmorrhage or exudates are found the condition is too grave for palliative treatment and pregnancy must be terminated. A high percentage of albumen, persisting in spite of treatment, is of almost equally grave significance.

The induction of premature labour in cases which resist medical treatment is perfectly justifiable and should not be delayed. It offers an escape from the risks of eclampsia,

and, the chances of the fœtus being already seriously jeopardised, the question can be weighed almost solely with reference to the interests of the mother. The treatment of eclampsia will be considered in connection with the complications of labour (p. 530).

Hyperemesis Gravidarum : Toxæmic Vomiting

The common occurrence of nausea and vomiting as a symptom of normal pregnancy, present usually from the second to the fourth or fifth month, has been mentioned on a previous page (p. 85). As a symptom it varies greatly in severity, but does not affect the patient's health and has no unfavourable influence upon the ovum. The disease known as hyperemesis gravidarum is met with at the same period of gestation and all gradations between ordinary morning sickness and the worst form of this disease may be met with. Great divergence of opinion has been expressed upon its causation, and it has gradually become evident that a number of different conditions have been included and described under the same name. Three groups of cases, the causation of which is essentially different, may be distinguished, viz., *associated* vomiting, *hysterical* vomiting, and *toxæmic* vomiting.

Associated Vomiting.—Such conditions as gastric ulcer, gastric cancer, alcoholic gastritis, cirrhosis of the liver, and cerebral disease—conditions which are all characterised by vomiting—when occurring in association with pregnancy, may give rise to intractable vomiting. These cases must therefore be excluded by careful clinical examination before the case can be considered as an example of vomiting due to pregnancy. Occasionally chronic intestinal obstruction in pregnancy has been overlooked on account of the obtrusive character of the vomiting, and the case treated as one of toxæmic vomiting, with disastrous results.

Hysterical Vomiting.—Severe and persistent nausea and retching are not infrequently met with in pregnant women of neurotic temperament ; no loss of flesh or other sign of illness accompanies it, and although troublesome the condition is of small clinical importance. But sometimes very severe vomiting from hysteria occurs in pregnancy. As a

rule, hysterical vomiting does not lead to loss of flesh, but wasting is often associated with severe forms of neurasthenia; and in pregnant women an alarming combination of the two symptoms of vomiting and loss of flesh is sometimes met with from hysteria. The urine, although diminished in quantity, from vomiting or from diminished intake of fluid, remains otherwise healthy. This point is of great importance in diagnosis. Other manifestations of hysteria are often present in such cases, and even in their absence the true nature of the case may be demonstrated by its being curable by strong mental impressions, by hypnotic suggestion, or by isolation. It is well known that in women of neurotic temperament the tendency to hysterical manifestations is greatly aggravated by pregnancy. Numerous cases have been recorded in which hyperemesis gravidarum has been cured by the treatment of such local conditions as backward displacement of the gravid uterus, laceration and erosion of the cervix, &c. Now these local conditions cannot be accepted as the cause of hyperemesis, for they frequently occur in pregnant women without leading to this symptom, and hyperemesis frequently occurs when they are absent. To say that the vomiting is ' reflexly ' excited by such pelvic lesions is an assumption for which no warrant exists. The cures recorded in such circumstances can only be attributed to ' suggestion '—*i.e.*, the mental effect produced upon a neurotic patient by the treatment adopted.

Toxæmic Vomiting.—To this class only a small proportion of the cases of excessive vomiting belong; although this class is small it is, however, very important for the cases are all severe and intractable, and a considerable percentage ends fatally. There are definite reasons for regarding these cases as toxæmic which may be stated as follows :—

(1) In fatal cases changes occur in the liver and kidneys of the same nature as those found in eclampsia (Plate III. *b*).

(2) The ammonia co-efficient is increased.

(3) In the later stages there may be partial anuria, the urine containing albumen blood, casts, acetone and diacetic acid, *i.e.*, a condition of acidosis is present.

(4) Pyrexia, rapid pulse and convulsions are often present, as in eclampsia.

(5) The condition is curable by terminating pregnancy, except in the most advanced stages.

It is improbable that the toxæmia is of the same nature as that of eclampsia, although there are many points of resemblance between them. Toxæmic vomiting occurs in the early months of pregnancy, while eclampsia is never met with before the fifth month. The clinical feature which characterises the one is vomiting, the other convulsions. Signs of renal involvement occur early in the one, late in the other. And again, according to most observers the hepatic changes, although consisting in both cases mainly of hæmorrhage and necrosis, commence in the centre of the hepatic lobule in pernicious vomiting, in the periphery of the lobule in eclampsia. The points of resemblance justify the view that both are chorionic toxæmias; the points of difference may be due to the fact that pernicious vomiting occurs before and eclampsia after the full development of the placenta. The placental chorion may perhaps produce toxins of a somewhat different kind from those produced by the early chorionic membrane.

Clinical Features of Toxæmic Vomiting.—In the early stages of the disease there is little or nothing to indicate the serious nature of the condition. The normal morning sickness of pregnancy may be unusually severe, and instead of abating it becomes more and more persistent. It is, as a rule, not until severe vomiting has been in progress for some time that any definite ill-effects appear. Then vomiting begins to occur independently of food being taken into the stomach, and in addition everything swallowed is rejected, but the vomit consists only of food and bile-stained fluid. The tongue remains clean, and the general condition is good. The next changes to appear are loss of weight and quickening of the pulse rate; the latter forms one of the most useful indices of the severity of the case, and a pulse rate persistently over 100 is always to be regarded as of grave significance. The tongue now becomes furred, and sometimes diarrhœa appears; sleeplessness and muscular twitchings are also sometimes met with. Severe epigastric pain is often complained of and the vomited matters may contain blood. Abortion may occur spontaneously, and rapid disappearance of the symptoms follows the evacuation of the uterus in the earlier stages of the disease.

If pregnancy continues the disease passes into its final

phase, characterised by a degree of anuria, the scanty urine containing albumen, and the other bodies just mentioned; slight icterus is often met with; the temperature often rises to 100° or over, although almost as frequently it will be subnormal; the pulse rate rises to 120 or higher, and a train of nervous symptoms develops which are of the gravest prognostic significance, viz. restlessness, loss of memory, low delirium, and convulsions or coma. If at this stage abortion should occur little or no benefit ensues from the evacuation of the uterus, and a fatal result is almost inevitable. The mortality of toxæmic vomiting is probably 50 to 60 per cent.

Diagnosis.—Cases of *associated* vomiting can be recognised only by careful clinical examination, and by bearing in mind the possibility of such a cause in every case of vomiting of pregnancy. Cases of the *hysterical* type are very difficult to distinguish from toxæmic cases in the initial stages; in both the only symptom may be intractable vomiting with a clean tongue and a normal pulse rate; but as a rule the hysterical cases are characterised more by nausea and severe retching than by the ejection of the actual stomach contents. Nevertheless cases of hysterical vomiting may occur in which wasting comes on from actual starvation. In such cases other signs of the neurotic temperament must be sought for, and in some cases the common 'stigmata' of hysteria, such as anæsthesia of the fauces, and points of spinal tenderness, may be found. The urine is normal, except that the ammonia nitrogen may be abnormally high. The favourable effect of isolation and trained nursing often confirms the diagnosis.

The points specially to be relied upon as indications of *toxæmic* vomiting are (1) the presence of acetone and diacetic acid, albumen and blood in the urine; (2) a *persistently* rapid pulse rate; (3) marked loss of flesh; (4) furring of the tongue, signs of jaundice, and delirium. When in doubt, it is better to regard the case as one of toxæmic vomiting and treat it as such. It will be noticed that in the later stages certain points of resemblance to eclampsia are met with in the condition of the urine and the appearance of coma and convulsions. These points must be considered in relation to the post-mortem appearances, which closely resemble those of eclampsia.

Treatment.—Before treatment is begun the greatest care should be exercised in excluding any organic disease to which the vomiting may be due, and in establishing the diagnosis of pregnancy. Time may be required to distinguish the *hysterical* type from the true toxæmic vomiting; when the hysterical factor is obvious the patient should be isolated from her friends and placed in charge of an experienced nurse. Cases of moderate severity should at first be treated by confinement to bed and careful feeding; small quantities —2 to 3 ounces—of milk or some peptonised food being given every two hours. If this is not retained, albumen water alone should be given for twenty-four hours, in small quantities at regular intervals, and rectal alimentation employed in addition. It may be necessary to stop all fluids by the mouth and use rectal alimentation alone for four or five days. Drugs are of little benefit, but the following may be given a trial: 1-minim doses of tincture of iodine well diluted every hour, bismuth with hydrocyanic acid, cocaine, and oxalate of cerium. In hysterical cases a quarter of a grain of morphia may be given hypodermically, followed a quarter of an hour later by a quantity of fluid food, such as egg and milk. The food will probably be retained and digested during the sleep which follows. Occasionally a hysterical case can be completely arrested in this way. Washing out the stomach will sometimes cure this form of vomiting also. Sinapisms applied to the epigastrium, and ice-bags to the spine, have been found useful.

Toxæmic cases, or cases assumed to be such, should in addition be treated by the 'eliminative method' described on p. 533. Venesection is usually unsuitable on account of the exhaustion produced by prolonged starvation, but the other methods are all useful when applied with care. When marked signs of acidosis are present, the indication is to administer large doses of an alkaline salt, together with a readily assimilable carbohydrate substance, such as glucose. Bicarbonate of soda should be given in sixty-grain doses, per rectum if necessary, and repeated every four hours until the reaction of the urine becomes definitely alkaline. Glucose can be administered in the same manner in doses up to 10 ounces of a 6 per cent. solution.

The *obstetric* treatment consists in the induction of

abortion. The evacuation of the uterus does not always arrest the vomiting; in the most advanced stages of the disease it has little effect. Induction of abortion, if undertaken in time, should prove to be a safe and easy means of arresting the disease, but the statistics of induced abortion are extremely unfavourable. This is probably due in the main to the fact that the condition of the patient has become desperate from delay before induction is resorted to. Lepage was able to report 66 per cent. of recoveries in a series of thirty-two recent cases in which induction was practised, but even this high mortality compares favourably with results published by previous observers. Induction should be advised before the febrile stage is reached. If vomiting persists in spite of eliminative and dietetic treatment, and is accompanied by a pulse rate of 100 or over, or by marked emaciation, and the presence of albumen in the urine, the patient's life is in great danger; there need be no hesitation at this stage in advising that pregnancy should be ended, without waiting for the appearance of symptoms of greater gravity.

The methods by which abortion may be induced will be considered in a later section.

We have next to consider certain minor disorders associated with pregnancy which may be included among the toxæmias, although their dependence upon toxæmia is, in the present state of our knowledge, a matter of assumption; they may eventually be shown to be indications of some other condition. *Ptyalism* or *Sialorrhœa* is sometimes extremely troublesome in the early months during the period at which morning sickness appears; sometimes it is associated with severe vomiting. Usually it is not of great clinical importance, but in rare cases it is associated with rapid wasting, and grave deterioration of the general health. Borissard has recorded a case in which the patient lost 13 kilos. (28 to 29 pounds) in a week. *Pruritus* limited to the external genital organs is of frequent occurrence during pregnancy, and, although troublesome, is never of grave importance. Sometimes, however, general pruritus affecting the skin of

the entire body occurs ; it may be associated with eruptions of erythematous or eczematous type, or the skin may be unaffected in appearance. General pruritus may lead to serious consequences from sleeplessness and exhaustion due to ceaseless irritation. Herpes sometimes of a severe type occurs during pregnancy, and has been named *herpes gestationis*. It occurs on the external genitalia and the trunk, and is very intractable to treatment. Cases have been recently recorded which have been successfully treated by eliminative methods and it is possible that the condition is of toxæmic origin. *Mental Disturbances.*—The liability of neurotic women to exacerbations of hysteria during pregnancy has been already referred to. Minor disturbances, such as sleeplessness, restlessness, and perversions of the appetite (longings), may also be met with ; when insanity occurs it is usually in single women, and is attributed largely to mental distress and apprehension.

Backward Displacement of the Gravid Uterus (Retroversion, Retroflexion)

In the majority of cases this condition results from the occurrence of conception in a uterus which is already retroverted or retroflexed ; more rarely a normally placed uterus becomes displaced during the first or second month of pregnancy by a fall, a violent muscular effort, or by overdistension of the bladder. Unless a history of such occurrences as these can be obtained, there is no means of distinguishing between the two modes of origin. The distinction between retroversion and retroflexion is not of practical utility, and no attempt need be made to consider them separately.

Backward displacement rarely gives rise to symptoms until the end of the third month has been passed (thirteenth week), and the symptoms which then appear are simply mechanical in their origin. At this period the gravid uterus is nearly globular in shape, having a diameter of from $3\frac{1}{2}$ to 4 inches (Fig. 44)—*i.e.*, it is nearly as large as the pelvic cavity in the living subject. It therefore exerts pressure upon the pelvic contents, giving rise to pain and interference with the functions of the bladder and rectum. The prominent and

characteristic symptom is retention of urine, either absolute or associated with continuous dribbling. Sometimes the onset of this symptom is sudden, the patient being completely unable to pass water ; usually the onset is gradual, frequency of micturition passing on to urinary incontinence. The sudden onset is always associated with great pain and

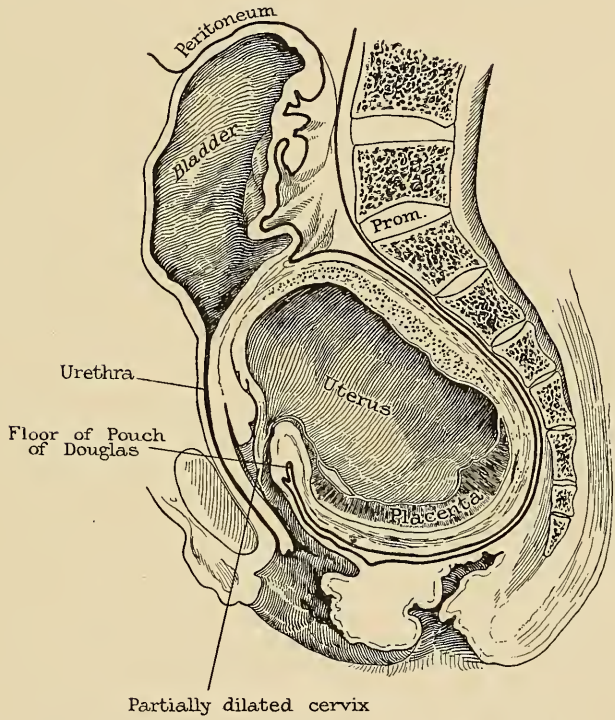


Fig. 57.—Retroflexed Gravid Uterus (three and a half to four months) with Distension and Rupture of the Bladder; Commencement of Abortion. From a Frozen Section. (Schwyzer.)

distress ; with the gradual onset the patient may be quite unconscious of the over-distended state of the bladder, which causes no pain. There may also be rectal tenesmus, and pain in the back and posterior aspects of the legs, but these symptoms are of minor importance.

The manner in which retention of urine is set up will be understood from Fig. 57. The gravid uterus is shown completely filling the pelvic brim and cavity, and causing a

certain amount of compression of the urethra against the back of the symphysis pubis. But more striking than compression is the great elongation of the urethra, which is almost double its normal length. This elongation results from two factors : (1) upward displacement of the cervix and stretching of the anterior vaginal wall, the external os being at the level of the upper border of the symphysis : (2) upward displacement of the lower part of the anterior uterine wall to which the base of the bladder is attached. These two anatomical changes cause elongation of the entire urethra ; this leads to narrowing of the lumen, which in turn increases the resistance to evacuation of the bladder, and so induces paralytic over-distension. If the sphincter becomes relaxed, incontinence occurs, with continuous escape of urine. In the figure it is seen that abortion, indicated by dilatation of the cervix, has commenced. The peritoneal investment of the bladder is convoluted, and the organ is partly collapsed, rupture having occurred in the over-distended state.

Clinical Course and Results.—Backward displacement giving rise to no symptoms may be met with accidentally in the second or third month : it usually becomes spontaneously reduced as the uterus develops. While the bladder remains over-distended, spontaneous reposition is impossible. In rare instances no urgent symptoms occur at all even at the critical period—the end of the third month—and the uterus continues its development in its abnormal position, giving rise to the condition known as *sacculation* of the uterus. This has been known to persist until term, and not to interfere with normal delivery. More commonly abortion takes place if the displacement remains uncorrected.

Serious results may ensue if the uterus becomes *incarcerated*. The word ' incarceration ' is loosely employed, and has no precise significance, but it may conveniently be used to denote any serious mechanical obstacle to reposition, such as pelvic contraction, especially of the *flat* variety (see p. 396), and peritonitic adhesions involving the uterus, which may have been in existence at the time of conception, or may have developed during the pregnancy. Such cases as these, when unrelieved, may become complicated by (1) rupture of the bladder ; (2) cystitis ; (3) gangrene and exfoliation of

the vesical mucous membrane; (4) uræmia or surgical kidney. With any of these complications prognosis is very grave.

Diagnosis.—The occurrence of marked disturbance of the functions of the bladder in association with three or four months' amenorrhœa should always raise the suspicion of backward displacement of the gravid uterus, and it must be remembered that troublesome frequency of micturition with slight incontinence may be the only symptoms to which the over-distended bladder gives rise. Sudden inability to pass water always brings the patient to seek immediate relief; but frequency and slight incontinence, when unassociated with pain, are often disregarded by her, and sometimes misinterpreted by her medical attendant. Careful abdominal and vaginal examination are required to determine (1) the state of the bladder, (2) the position of the uterus.

On *abdominal* examination an over-distended bladder reveals itself as a soft, non-tender, fluctuating swelling, superficial in position, and reaching well above the umbilicus in extreme cases. Its size alone will serve to distinguish it from the gravid uterus at the third or fourth month. Any doubt will, of course, be dispelled by passing the catheter. Until the bladder has been evacuated, nothing further can be detected on abdominal examination. Signs of activity in the breasts should be noted as being presumptive of pregnancy.

On *vaginal* examination the conditions will be found which are shown in Fig. 57. The first point which attracts attention is the forward bulging of the posterior vaginal wall, due to depression of the floor of the pouch of Douglas, and filling up of the sacral hollow by the body of the uterus, which is felt as a smooth, tense, elastic swelling. In consequence the direction of the vaginal canal is altered so that it passes from below upwards and a little forwards, instead of upwards and backwards. The next point to be noticed is the inaccessibility of the cervix, which cannot be found at the usual level, but lies high up behind the symphysis pubis. Often the posterior lip alone can be reached, and sometimes the cervix is entirely inaccessible to touch without employing anæsthesia for the examination. The greater the degree of flexion present, the easier will it be to reach the cervix; in a

simple retroversion the external os may lie well above the level of the upper border of the symphysis. After evacuation of the bladder the bimanual examination will show that the swelling felt through the posterior vaginal wall is the gravid uterus, and examination per rectum will allow of much more complete palpation of the displaced uterus than the vaginal examination. Confirmatory signs of pregnancy may be found in softening of the cervix, and purple discoloration of the mucous membrane of the vulva. Finally, an attempt should be made to estimate the mobility of the uterus, by endeavouring to lift it upwards and forwards in the pelvic axis with the examining finger. The presence of pelvic contraction should not be overlooked as a cause of incarceration ; adhesions are very difficult to diagnose, and their presence will not, as a rule, be suspected until it is found that some unexpected obstacle to replacement exists.

Differential Diagnosis.—There are only two conditions which may be said closely to resemble retroversion of the gravid uterus—viz., *pelvic hæmatocele* (almost always due to extra-uterine gestation), and a *fibroid tumour in the posterior uterine wall.* The former will be considered in a subsequent section (see p. 193). With regard to the latter, the differential diagnosis is easy if the fibroid uterus is not gravid, but very difficult if pregnancy has occurred ; in the latter case the physical signs may so closely resemble those of a retroverted gravid uterus as to deceive the most experienced clinical observer. The following symptoms usually afford valuable aid in distinguishing these conditions, as may best be indicated in a table thus :

I. Retroverted Gravid Uterus.	II. Fibroid in Posterior Wall.	III. Fibroid in Posterior Wall + Pregnancy.
1. Amenorrhœa	Normal menstruation or menorrhagia	Amenorrhœa or slight irregular hæmorrhage
2. Signs of pregnancy in Breasts (primigravida), Cervix, and Vulva	Occasionally secretion in Breasts No signs of pregnancy in Cervix and Vulva	Signs of pregnancy in Breasts(primigravida), Vulva, and Cervix
3. Retention of urine	Retention of urine	Retention of urine

The great majority of fibroids are hard and quite unlike the gravid uterus in consistence, but sometimes these

tumours become softened from œdema or cystic degeneration ; and although multiple fibroids cause the outline of the uterus to become irregular, a single interstitial or submucous growth will cause a symmetrical enlargement not unlike that of pregnancy. Softening of the cervix is often delayed when pregnancy occurs in a fibroid uterus. These facts, together with the tendency of fibroids occupying the posterior uterine wall to occasion retention of urine, are the chief causes of the difficulties in diagnosis. The immediate treatment of I. and III. being the same, their differential diagnosis is not of great practical importance.

Other swellings, such as a small ovarian cyst, are not infrequently found occupying the pouch of Douglas and displacing the cervix forwards against the symphysis pubis. They seldom, however, cause retention of urine, for the reason that they do not occasion that elongation of the urethra to which retention is largely due in the case of the retroverted gravid uterus. The differential diagnosis can usually be made by localising the uterus, which will be found to be of normal size and to lie in front of the swelling, and distinct from it. None of the signs or symptoms of pregnancy will be met with.

Treatment.—Cases of backward displacement sometimes come under observation before the functions of the bladder have been interfered with ; sometimes the condition is discovered by accident, sometimes the patient comes complaining of backache. At this period no attempt should be made to replace the uterus ; the manipulations required are painful and sometimes difficult ; abortion not infrequently follows them even when they are successful ; and in addition, replacement is not required. The patient should be put to bed and kept resting for 10 to 14 days ; symptoms such as backache always disappear, and in most cases about the end of the third month the uterus will rise spontaneously out of the pouch of Douglas into the normal position. She should be directed to lie prone on her face for several hours at a time, and if possible, to sleep in that position.

After retention of urine has occurred, the best method of treatment is rest in bed with the regular use of the catheter three times in 24 hours ; in the majority of cases spontaneous ascent of the uterus occurs after three or four days ; in

others, however, some method of replacement may be required, but resort should not be made to these methods until the expectant method has failed.

Methods of Replacement.—The two chief methods made use of are : (1) manipulation aided by posture, anæsthesia, or prolonged rest ; (2) continuous pressure.

(1) *Manipulation.*—The simplest application of this method is to place the patient in Sims's position (Fig. 159) and, the bladder having been evacuated, to endeavour to push the fundus upwards and forwards in the direction of the axis of the pelvic brim ; this may be done with two fingers passed into the vagina, or with the index finger in the vagina and the middle finger in the rectum, which allows of pressure being more effectively applied to the retroverted fundus. Further aid may also be obtained by seizing the anterior lip of the os externum with a volsella and drawing it downwards while the fingers push the fundus upwards. This, however, will not succeed unless the patient is tolerant of pain and will avoid straining. When the fundus has been raised above the pelvic brim, the cervix should be pushed back towards the sacral hollow and the body drawn forwards towards the pubes with the external hand. Precisely the same manœuvre may be attempted with the patient in the knee-elbow or the knee-chest (genu-pectoral) position (Fig. 58), which brings in the aid of gravity to a greater extent, the uterus tending to fall towards the dependent abdominal walls. If an anæsthetic is administered, so as to abolish completely the muscular reflexes, manipulation will often succeed after being employed unsuccessfully without it. The position of the patient is unimportant when under anæsthesia. Even when manipulation fails at first, it may succeed after a few days' rest in bed, and the use of saline purgatives and hot vaginal douching.

In Sims's position the patient lies on her left side with the left arm behind her, and both knees drawn up to the abdomen, the right higher than the left. The knee-elbow and knee-chest positions will be more fully described in a later section (see p. 391).

(2) *Continuous Pressure.*—This method is applied by passing into the vagina the hydrostatic dilator known as the de Ribes bag (see p. 664), distending it with air or water

(preferably the former), and allowing it to remain for a period of six hours at a time. This continuous elastic pressure from below, when applied intermittently for a few days, sometimes succeeds after manipulation has failed, but it causes considerable pain.

Cases which resist these methods of replacement are very uncommon, and are due either to contraction (flattening) of the pelvic brim or to the presence of adhesions. In the former condition spontaneous abortion will in all probability

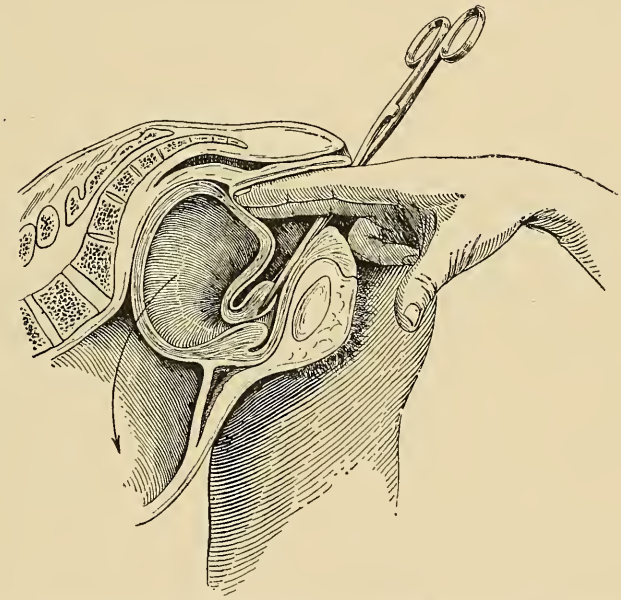


Fig. 58.—Replacement of Retroverted Gravid Uterus by Manipulation in Genu-Pectoral Position. (Bumm.)

occur ; in the latter it is best to allow the gestation to continue to term, when there is good hope of spontaneous delivery taking place.

Anteflexion of the Gravid Uterus.—During the last three or four months of pregnancy, when the uterus is imperfectly supported by the lax abdominal walls so often found in a multipara, the fundus tends to fall forwards, producing unusual protrusion of the abdomen. This may become exaggerated by the uterus passing between the recti muscles, when they have become separated from one another by a

distinct interval ; the uterus being then supported only by the cutaneous structures of the abdominal wall, the fundus may come to lie at a lower level than the symphysis pubis, producing the condition called *pendulous belly* (Fig. 59). The same condition may result from, or be exaggerated by, extreme pelvic contraction, preventing the descent of the fœtus into the pelvic brim ; or spinal curvature, displacing the uterus forwards. It naturally causes considerable discomfort when the patient is in the erect position, and if uncorrected may lead to rupture of the uterus during labour. Occasionally an atypical form of anteflexion results from previous fixation of the uterus by hysteropexy or vaginal fixation, and serious obstruction in labour sometimes results. The *treatment* during pregnancy consists in wearing a strong well-fitting abdominal belt.

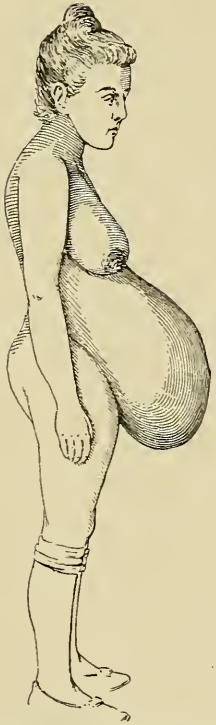


Fig. 59.—Anteflexion of the Gravid Uterus: Pendulous Belly. (Ribemont-Dessaignes and Lepage.)

Prolapse of the Gravid Uterus.—A completely prolapsed uterus (procidentia) very rarely becomes gravid. If pregnancy should occur, spontaneous ascent usually takes place about the third month ; but the uterus may become 'incarcerated,' when spontaneous abortion will almost inevitably occur. Minor degrees of prolapse of the uterus are frequently met with in pregnancy ; they only require treatment during the first three or four months, as after this period the uterus has risen into the abdomen and is supported by the pelvic brim. A ring pessary of suitable size is generally successful.

Hernia of the Gravid Uterus.—Very rarely the uterus forms part of the contents of an inguinal hernia, and in that position it has been known to become gravid. This condition is naturally more likely to affect a bicornute uterus, one horn being drawn into the hernial sac. Sometimes also

the gravid uterus may enter the sac of an umbilical or a ventral hernia ; but this is rare, as the uterus, by the time it reaches the level of the hernial aperture, is usually too large to enter the sac.

Malformation of the Uterus and Pregnancy.—Few malformations of the uterus possess any obstetrical significance.

Double Uterus (Uterus didelphys ; Uterus bicornis).—When pregnancy occurs in one half of a double uterus, the

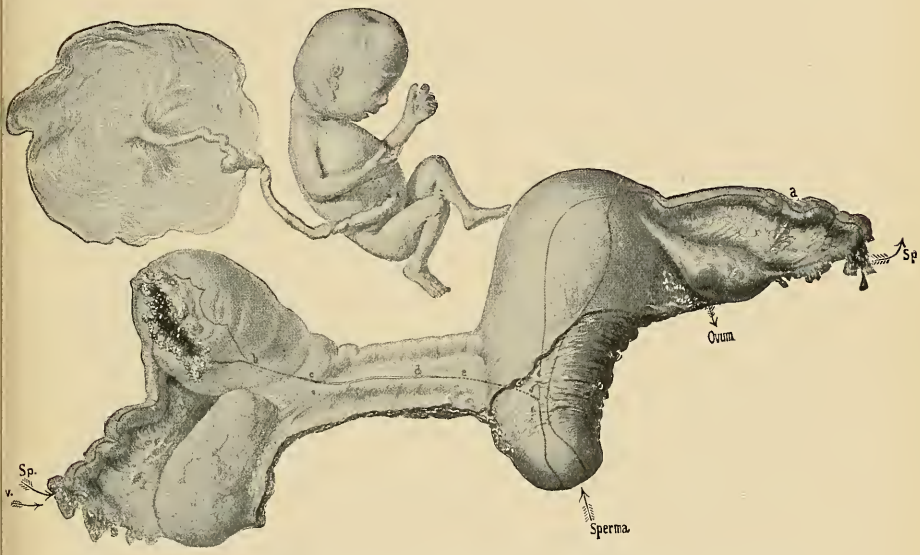


FIG. 60.—Pregnancy in a Rudimentary Left Uterine Horn. (Kelly.)

To the right is the well-developed uterus. Attached to the cornu is the right tube, which is normal. The right ovary is of the usual size, and at its inner and lower portion is a corpus luteum. Springing from the left side of the uterus at the level of the internal os is a muscular band ; on tracing this to the left it merges into the rudimentary uterine horn. On the posterior surface of this horn is a long slit representing the point of rupture. The left tube passes off from the gravid portion of the rudimentary horn. The arrows indicate the course of the spermatozoa and ovum from the cervix and right ovary (respectively) to the rudimentary left horn. This is an instance of 'external wandering.'

non-gravid half undergoes marked softening and enlargement, while a complete decidual membrance is formed within it. The course of pregnancy and labour may be unaffected, and although the portio vaginalis and vagina may be duplicated, the condition often passes unrecognised. In binovular twin pregnancy an ovum may be lodged in each half. Occasionally in a uterus bicornis the non-pregnant horn becomes displaced, and forms an obstruction to delivery.

Bicornute Uterus with Rudimentary Horn.—Sometimes a bicornute uterus possesses only one fully developed horn, the other being rudimentary ; as a rule the lumen of the rudimentary horn has no connection with the fully developed one (Fig. 60). Pregnancy may occur in the rudimentary horn by external wandering of the spermatozoa ; the fertilised ovum may come from the ovary of the same side as the rudimentary horn, or from the opposite one ; in the latter case it must cross the pelvic cavity to enter the abdominal ostium of the rudimentary horn (external wandering of the ovum). Pregnancy in this position usually ends in rupture of the gravid horn, and is mistaken clinically for tubal gestation.

Pressure Symptoms

In the lower extremities and upon the lower part of the abdominal wall, *anasarca* usually appears to a slight extent during the last two months of a first pregnancy, and sometimes in later pregnancies also. It is due mainly to impeded venous return from these parts, the obstacle being the compression exerted by the gravid uterus upon the iliac veins at the pelvic brim. The labia majora may also become œdematous, and form swellings of considerable size even when there is no albuminuria. Occasionally only one labium or one leg is affected with anasarca. *Varicose veins* often appear in the lower extremities, and vagina or vulva during pregnancy, being caused in the same way as anasarca. Spontaneous rupture of a varicose vein during pregnancy sometimes occurs and leads to severe or sometimes to fatal bleeding. When the ruptured vein is in the vaginal wall the case is very likely to be mistaken in the first place for one of ante-partum hæmorrhage, and only a careful search with the aid of a speculum will lead to a correct diagnosis. Vulval varices may give rise to serious bleeding from injury during pregnancy, or from rupture during labour. *Hæmorrhoids* are often produced or aggravated during the later months of pregnancy. *Cramp* in the muscles of the legs, either spontaneous or when walking, is often very troublesome during the last few weeks, and is probably due to pressure upon the nerves of the lumbosacral plexus.

The *treatment* of these pressure symptoms consists, in the main, of rest in the horizontal position. In cases of œdema careful examination of the urine must of course be made, as, if albumen is present, the aspect of the case is entirely altered. It is better not to undertake operations upon varicose veins or hæmorrhoids during pregnancy, as continuation of the pressure prevents a satisfactory result.

Uterine Moles

The term ' mole ' is applied to an ovum destroyed by pathological conditions affecting its coverings during the early months of gestation. Two kinds are recognised, the *Blood Mole* and the *Hydatidiform Mole* and both may occur in either uterine or extra-uterine gestation. Moles are often colloquially termed ' False Conceptions.'

I. **The Blood Mole** (Synonyms : Carneous or Fleshy Mole, Hæmatoma Mole).—The blood mole results from the destruction of the ovum by progressive or recurrent hæmorrhage, usually but not invariably occurring before the formation of the placenta—*i.e.*, during the first three months of pregnancy. The general structure of the ovum at this period is shown in Figs. 11 and 20. It is completely enveloped in the thick, very vascular, decidual membrane ; the chorion is separated from this membrane by a narrow space continuous around the whole ovum, termed the chorio-decidual space ; this space contains maternal blood and is traversed by the delicate branching villi which spring from the outer surface of the chorion, and some of which are loosely attached by their tips to the decidual surface. The morbid process starts in hæmorrhage from maternal vessels into the decidual tissues, followed by extravasation of blood into the chorio-decidual space, which will break up and destroy the delicate villi at the affected spot (Fig. 61). A sudden and extensive hæmorrhage of this kind would no doubt cause rupture of the decidua capsularis, or complete detachment of the ovum, both of which accidents would quickly lead to abortion. But the blood mole is formed by repeated slight hæmorrhages or by a slowly progressive hæmorrhage, which does not cause rupture of the protective decidual covering of the ovum. The effused blood is free to surround the ovum, more or less

completely, by following the chorio-decidual space ; hæmorrhage sometimes starts independently at different spots (Fig. 61). The result is the more or less complete destruction of the chorionic membrane and its villi. The amnion, being very elastic, is able to resist the external pressure to which it

Fig. 61.—Tubal Pregnancy: Section of the Ovum *in situ*, demonstrating the Early Stage of Formation of a Blood Mole. Hæmorrhage has occurred into the Chorio-Decidual Space, breaking up large numbers of Villi. (Couvelaire.)

is subjected ; consequently the amniotic sac is usually found free from blood in these cases. The fœtus perishes and may be completely absorbed ; sometimes it remains and is found more or less disorganised by maceration in the liquor amnii. Occasionally, however, the amnion is totally destroyed. The effused blood is usually unequally distributed around the ovum, and forms an irregular series of abrupt polypoid

elevations (Fig. 62), covered by the amnion, with deep intervening sulci; this causes marked distortion and narrowing of the amniotic cavity.

In Figs. 61 and 62 two stages in the formation of a blood mole are shown; the drawings were made from cases of

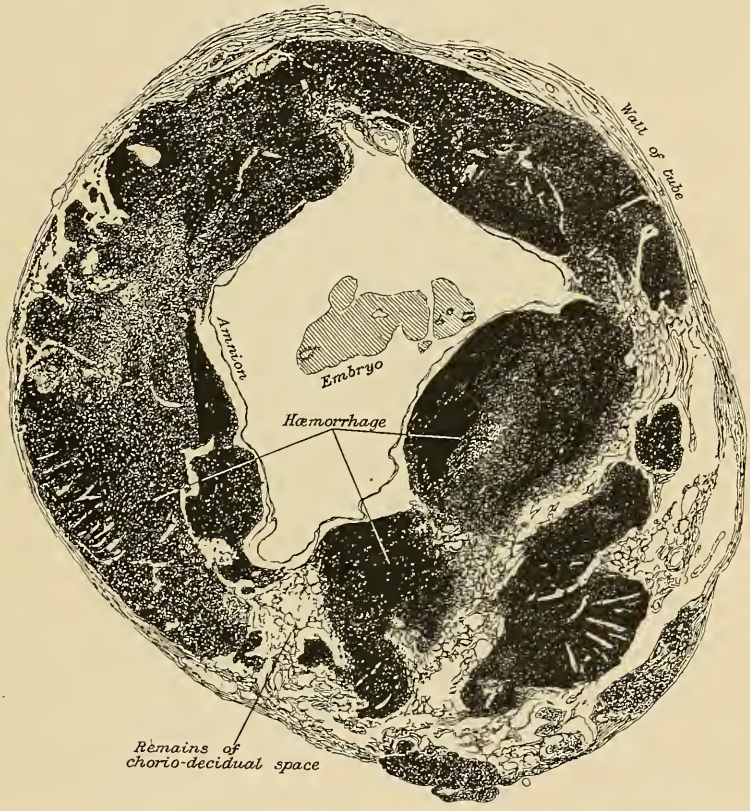


Fig. 62.—Tubal Pregnancy: Section of the Ovum *in situ*, demonstrating the Late Stage of Formation of a Blood Mole. (Couvelaire.)

tubal gestation, and therefore they illustrate primarily the mode of formation of a tubal mole; but the process is probably identical with that which occurs in the uterus. Opportunities of examining a uterine mole *in situ* very seldom occur, but in the case of a tubal mole they are fairly common, as gravid tubes are usually removed by operation. In Fig. 61 hæmorrhage has occurred at two distinct areas of

the chorio-decidual space; the effused blood is bounded internally by the unruptured chorionic membrane, and within this by the amnion. As there is little or no decidual formation in the gravid tube, the hæmorrhage appears to be limited externally by the tube-wall. The amniotic sac and the embryo appear to be unaffected. In Fig. 62 a later stage of the process is shown. Extensive hæmorrhage has

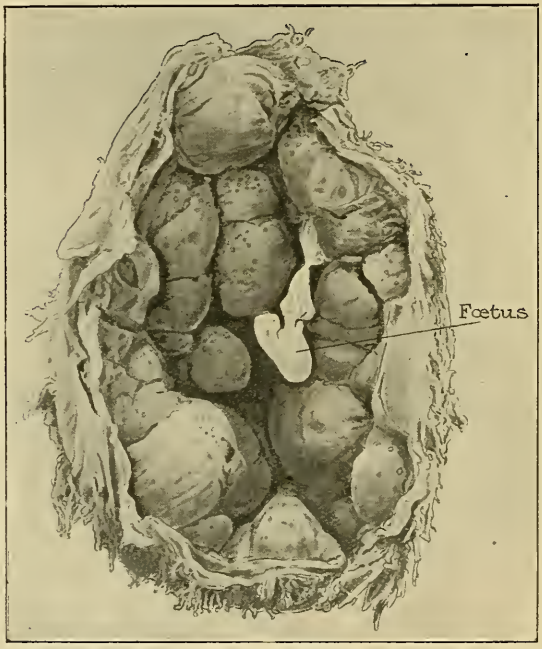


Fig. 63.—Fleshy Mole: Four Weeks' Gestation, retained until the Seventh Month. (Charing Cross Hospital Museum.)

occurred, which entirely surrounds the ovum; it is limited internally by the amnion alone, and the amniotic sac is small and distorted, but still contains a trace of the body of the embryo; the chorionic membrane has been completely destroyed. Irregular protuberances with intervening sulci are seen on the amniotic aspect. The hæmorrhage is almost entirely maternal in origin; no doubt some admixture of fœtal blood also occurs, but its amount must be inconsiderable, owing to the small size of the embryo at this period. A

blood mole discharged in a fresh condition—*i.e.*, soon after the occurrence of the hæmorrhage—is sometimes called an *apoplectic ovum*.

An ovum thus destroyed may be retained *in utero* for many weeks or months ; the effused blood then undergoes consolidation from absorption of its fluid constituents, and the wall of the dead ovum becomes firm and ' fleshy ' in consistence (carneous or fleshy mole, Fig. 63). On section, the wall of the carneous mole is sometimes seen to be partially laminated, indicating that it has been formed by repeated hæmorrhages ; sometimes strands of fibrous tissue traversing it can be recognised, indicating remains of the chorion. On microscopic examination degenerated chorionic villi imbedded in blood-clot, will be found in it.

In a certain number of fleshy moles there is a marked disproportion between the size of the amniotic cavity and the stage of development of the fœtus. This is well shown in Fig. 63, where the fœtus measures 8 mm. in length (three to four weeks), while the amniotic sac measures $2\frac{1}{2}$ inches by $2\frac{1}{2}$ inches (nine to ten weeks). A healthy fœtus is never found in a carneous mole. Occasionally the fœtus has disappeared altogether ; more commonly it is disproportionately small, and is shrivelled to an extent which obscures all its characteristic features. The umbilical cord is similarly altered. These changes follow the death of the fœtus and are due to *autolysis*, a process by which the albuminous constituents of the tissues are converted into soluble substances, which are taken up into the liquor amnii and thus disappear. Marked disproportion in size between the fœtus and the amniotic sac is probably due in part to autolysis of the fœtal tissues, and in part to an excessive production of liquor amnii (hydramnios). It is possible that the hydramnios was present in these cases before the formation of the mole began, the hæmorrhagic process being started by the stretching to which the decidua was subjected by the abnormally large ovum. This point is, however, still the subject of dispute, and in any case hydramnios is not to be regarded as an essential factor in the production of a blood mole.

We can only speculate upon the conditions which give rise to hæmorrhage in the early ovum. Syphilis, chronic

Bright's disease, and endometritis are believed to be concerned in its production, but upon inconclusive evidence. The great vascularity of the decidual membrane, the imperfect external support furnished by the decidua capsularis at this period, and the delicacy of the young chorionic attachments, make it probable that even in the case of a healthy ovum slight traumatic disturbances may start the process.

The *symptoms* which attend the formation of a uterine mole are indefinite. In most cases a train of symptoms, to be described later on as those of 'threatened abortion,' occur, which subside, and then nothing else is noted until the ovum is cast off. This event, which may take place within a few weeks or be delayed for many months, is known as a 'missed abortion.' The process does not differ in any respect from that subsequently to be described as 'inevitable abortion.' The *diagnosis* is naturally a matter of some difficulty, and can really only be solved by the expulsion of the mole. From the clinical standpoint these cases come under observation as cases of abortion, and are to be treated as such. Interference is seldom required, but if the uterine discharge should become offensive (infection of the ovum), the treatment consists in dilating the cervix and clearing out the uterine contents in the manner described under the treatment of abortion.

II. **The Hydatidiform Mole** (Synonyms : Vesicular Mole ; Hydatidiform Degeneration of the Chorion).—This condition is a disease of young chorionic villi, characterised by the formation of immense numbers of irregular clusters and chains of cysts which vary in size from extreme minuteness up to $\frac{4}{5}$ inch in diameter. Cases have, however, been recorded in which the largest vesicles measured $1\frac{1}{2}$ inches in long diameter. The superficial resemblance of these cysts to hydatids originated the name by which this condition is known, but it must be understood that the hydatidiform mole has really nothing in common with echinococcal cystic disease. The naked-eye appearance of this mole is so characteristic that its recognition is very easy.

The disease has been observed as early as the third week of pregnancy, and in such cases the whole of the chorionic membrane, being villous, may be affected in the manner represented in Fig. 64. It probably begins in all cases at a

comparatively early period, for it is quite exceptional for any trace of the fœtus or the amniotic sac to be found. As a rule the contour of the ovum is completely lost, and a mass of vesicles is formed, having no definite arrangement whatever and assuming the contour of the distended uterine cavity.

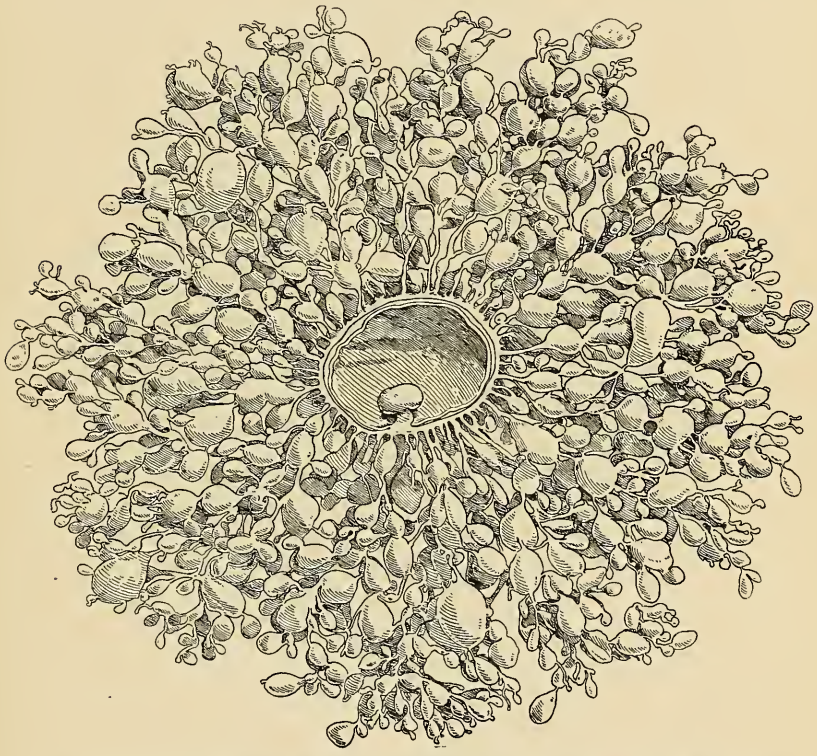


FIG. 64.—Hydatidiform Mole (Diagrammatic): the Entire Chorion is affected by the Disease; the Amniotic Sac is seen in the centre. (Bumm.)

The formation of vesicles may be so abundant as to produce a mass weighing 4 to 5 pounds. The general relations of the mole are well shown in Fig. 65, which represents the mole as seen *in situ*, the uterus having been removed by supra-vaginal hysterectomy. The cystic villi are closely packed together, and the interstices between them are filled with blood derived from the maternal decidua. The villi are

attached to the uterine wall in the greater part of its extent ; on the right of the uterus, however, a narrow space filled with blood-clot lies between the mole and the uterine wall ; this represents the *decidual space*. The internal os is partly

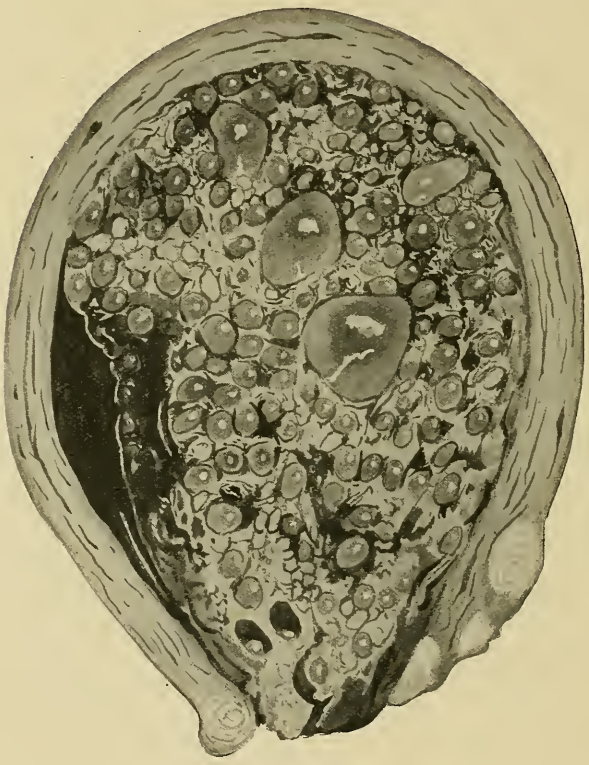


Fig. 65.—Vesicular Mole *in situ*. The Uterus was removed by Supra-vaginal Hysterectomy. (Haig Ferguson.)

dilated, allowing the lower pole of the cystic mass to protrude into the cervical canal.

Occasionally the disease may begin at a later period when the formation of the placenta is advanced, and the greater part of the chorion is non-villous. The degenerative changes are then usually partial, and affect a portion of the placenta only, so that the general shape of the organ may be retained and the body of the fœtus be recognisable. This is well

illustrated in Fig. 66, which represents a placenta infiltrated by hæmorrhage and partially affected by vesicular degenera-

Fig. 66.—Placenta with extensive Hæmorrhage and Vesicular Degeneration of the Chorion. Note the Cysts imbedded in Blood-clot. (Charing Cross Hospital Museum.)

tion. A considerable number of instances have now been recorded in cases of extra-uterine gestation.

The vesicles themselves are oval or globular grape-like bodies, pale yellowish in colour, and semi-translucent. Each vesicle is stalked, the pedicle being delicate and short. The vesicles may be arranged in chains, or in clusters of irregular shape ; when pricked or incised they exude a thin fluid. The decidua in cases of vesicular mole is usually abnormally thick, and shows considerable round-celled infiltration on microscopic examination. This may, perhaps, be regarded as a defensive change which enables the decidua to offer greater resistance to the eroding action of the chorionic epithelium and thus to protect the uterine wall against abnormal penetration.

The microscopic characters of the vesicles present the curious association of abnormally active proliferation of both the syncytial and cellular layers of the chorionic epithelium, with degeneration of the connective-tissue stroma. The vesicles all possess a complete epithelial wall. In the larger vesicles the stroma and the blood-vessels are completely destroyed, and only a few degenerated nuclei persist ; the contents are entirely fluid. In the smallest vesicles the stroma may be fairly normal, in those of medium size a layer of altered and compressed connective tissue may be found immediately under the epithelium, the centre of the vesicle containing only fluid (Fig. 67). Mucoid (myxomatous) degeneration was originally supposed to be the nature of these changes in the stroma, but it has now been established that the fluid found in the vesicles contains no mucin ; some other form of colliquative necrosis is therefore the probable cause. The epithelial covering of many vesicles shows remarkably active proliferation of the syncytial layer. In others the epithelium shows no abnormal changes whatever. In Fig. 67 are seen numerous buds and processes springing from the syncytium, and also isolated sections of such processes springing from neighbouring villi (syncytial buds). The change in both the epithelium and the stroma will be best appreciated by comparing Fig. 67 with Fig. 22, representing the same structures in a young normal villus. Unusually active proliferation of the cells of Langhans is also generally found. This abnormal epithelial proliferation, although not of universal distribution, forms a characteristic feature of these moles.

An important result of this abnormal activity on the part of the chorionic epithelium is that it possesses powers of penetrating the uterine wall which exceed those of normal villi. The eroding properties of this tissue have been already referred to in connection with the normal ovum. It has been generally believed from clinical observations that the

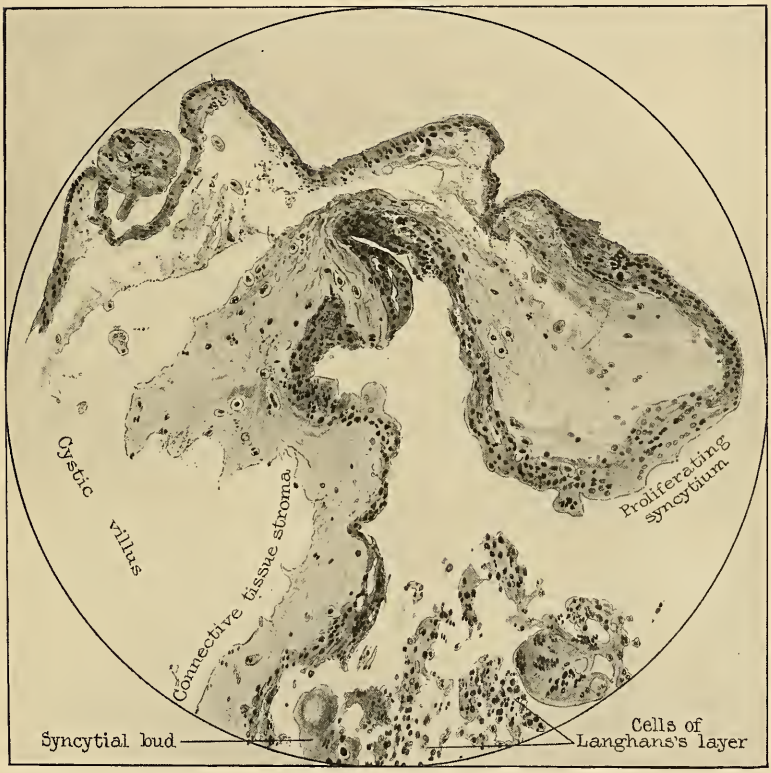


Fig. 67.—Hydatidiform Mole; Section through a Chorionic Villus.

cystic villi eroded the uterine wall to an unusual extent, causing dangerous thinning. A few cases have been recently recorded in which a mole was examined *in situ* after the removal of the uterus from the body. These exact observations do not support this view, for the uterine wall has not been found abnormally thin in any instance. But there is no doubt that in certain instances the eroding power of the villi is so great as to cause spontaneous perforation of

the uterine wall, leading usually to death from hæmorrhage or peritonitis. This variety is known as the *perforating* or *malignant hydatidiform mole;* it is closely allied in histological characters to chorion epithelioma (deciduoma malignum), and is frequently followed after an interval by the appearance of this formidable new growth (see p. 607). The property of destroying healthy tissues is one of the chief characteristics of malignant disease, and quite justifies the term ' malignant ' being applied to this form of mole. With the remarkable activity of the chorionic epithelium must be contrasted the fact that the degenerated villi are completely devascularised and the embryo destroyed. This fact well illustrates the truly parasitic nature of the degenerated villi. They receive no blood supply from the fœtus, but are nourished by the maternal blood with which they are in contact, and are thus enabled to grow and to proliferate. It has been already pointed out that the probable source of the nutrition of healthy chorionic villi is also the maternal blood of the intervillous spaces. In the vesicular mole there is no intervillous maternal circulation, but at the same time a considerable quantity of maternal blood is found between the cysts, the source of which is necessarily the uterine wall.

Nothing is definitely known as to the *causation* of the hydatidiform mole, though there has been much speculation about it. Some authorities believe that an unhealthy condition of the decidua induces the morbid change in the chorion, but others consider that it arises primarily in the chorion itself. It appears to be more reasonable to regard it as an embryonic disease, and this view is supported by the fact that in twin pregnancy it sometimes affects one ovum only. If the cause lay in the decidua, both ova would certainly be affected. It may occur at any time in the reproductive period, but is most commonly met with in the decennial periods 20 to 30 and 40 to 50. It is a distinctly rare condition, occurring probably in about 1 in 2,000 to 2,500 pregnancies.

Within recent years it has been pointed out that cystic tumours of the ovary occur in association with vesicular moles with such frequency that a casual connection between the two may be considered probable. Thus, Krömer has

recorded a series of seventeen moles, in ten of which the presence of an ovarian tumour was clinically recognised. Further, it has been shown that these ovarian tumours are usually cysts which have arisen in the corpus luteum, and are in some way the result of abnormal proliferative activity of the lutein tissue. It has accordingly been suggested that perverted ovarian activity may prove to be an important factor in the production of these moles, but in the meantime it cannot be said that this theory has been satisfactorily proved.

Clinical Features.—Two symptoms are commonly met with in this condition : (1) undue enlargement of the uterus ; (2) hæmorrhagic discharge. They always begin in the *first half* of pregnancy.

(1) Undue enlargement of the uterus, although usual, is not invariably found. Occasionally the size corresponds to the presumptive duration of pregnancy : occasionally the uterus is disproportionately small. In the great majority, however, it is disproportionately large ; thus the fundus may extend up to the umbilicus three months after the cessation of the last regular monthly period ; a less pronounced disparity than this is, however, more common. But it must be remembered that over-enlargement of the uterus at the third or fourth month may occur from other causes. The large uterus occupies the normal mesial position of the womb. In exceptional cases it has been described as extending up to the ensiform cartilage ; but it not infrequently reaches considerably higher than the umbilicus. It possesses a peculiar doughy consistence. It is exceptional for the fœtal heart-sounds to be heard, even when the uterus is of the size of six or seven months' pregnancy, because, except in rare instances, there is no fœtus. Vesicular degeneration sometimes, however, in a twin pregnancy affects one ovum only, and then of course the heart of the surviving fœtus may be heard. As a rule the uterine souffle cannot be detected, nor can intermittent contractions be felt.

(2) The discharge usually appears during the third or fourth month, *i.e.*, at a time when the disease has been already in existence for some weeks. It is commonly small in amount, more or less continuous, thin and watery in character, reddish or reddish-brown in colour, and unattended

by pain. Severe hæmorrhage is rarely met with except during the process of abortion, when it may be very profuse. In rare instances the discharge may possess characters which are pathognomonic, detached vesicles being found in it; but this is uncommon and must not be anticipated. Sometimes the discharge solidifies, forming a red jelly in which pale vesicles may be found.

The over-enlargement of the uterus is of course due to the bulk of the diseased ovum, which may be enormous; its peculiar consistence is due to the absence of the amniotic fluid sac, which gives to the normal gravid uterus its characteristic elasticity. The hæmorrhage is probably occasioned by the detachment of vesicles from the uterine wall, and by rupture of vesicles; the discharge therefore consists partly of maternal blood and partly of the fluid contents of ruptured vesicles. After the hæmorrhage has persisted for a variable period, spontaneous abortion almost always occurs.

The general condition of a patient with a vesicular mole is often unfavourably affected to an extent not to be accounted for by the amount of hæmorrhage which has occurred. Morning sickness is often unusually severe, and toxæmic symptoms of a mild type are sometimes recognised. In a certain proportion of cases, at present undetermined, chorion-epithelioma supervenes, either immediately upon the evacuation of the mole or after an interval. In Krömer's seventeen cases, chorion-epithelioma subsequently occurred in seven, but this is almost certainly an unusually high proportion.

Diagnosis is often uncertain, and can only be settled by the discovery of vesicles; if none are discharged spontaneously, the finger may sometimes feel them in the cervical canal if the internal os is a little dilated. In the absence of this sign it may be said that marked over-enlargement of the uterus, with persistent or repeated hæmorrhage at the third or fourth month of pregnancy, is suggestive of a hydatidiform mole.

Treatment.—This consists in all cases in artificial evacuation of the uterus. Spontaneous abortion of a hydatidiform mole is a very long and tedious process, resulting in considerable hæmorrhage; being almost invariably incomplete, it

must be terminated by interference. The uterus in these cases appears to be unable to expel its contents, and it is therefore best, when the diagnosis has been made, to evacuate it without delay. This procedure is fully described in connection with the induction of abortion (p. 653). The cervix is usually slightly patulous, and can readily be dilated sufficiently to admit one finger ; if more room is desired the cervix must be divided as described on p. 658. With the finger, aided by a pair of blunt forceps or ovum forceps, the mass of vesicles can be broken up and removed piecemeal. What seems at first, on account of the size of the uterus, a task almost impossible for the fingers alone, becomes easier as the process advances, the uterus gradually diminishing in size so as to bring the fundus within reach. The curette is unnecessary, and even in experienced hands may lead to perforation of the uterine wall. Care should be taken to detach all the vesicles and decidua from every part, and the uterine cavity should then be thoroughly douched with a weak antiseptic solution and, if retraction is unsatisfactory, packed with bismuth gauze. There are special risks in the puerperium of sepsis, sub-involution, and, remotely, of the development of chorion-epithelioma.

Decidual Endometritis

Acute decidual endometritis has been observed in cases of ascending gonorrhœa in pregnant women, the gonococcus having been demonstrated in the decidual membrane. So far as we know, this is the only variety of acute inflammation of the decidua arising spontaneously during pregnancy ; but acute septic inflammation from operative interference may, of course, also be met with. *Chronic* decidual endometritis is more common, and is believed to result from implantation of the ovum upon an unhealthy endometrium. The membrane is unusually thick and fleshy, and often shows numerous small cysts beneath the epithelium, which arise from irregular dilatation of the deep parts of the uterine glands. Although decidual endometritis is undoubtedly a genuine cause of abortion, its clinical recognition is impossible in the present state of our knowledge ; diagnosis can only be made

from examination of the membrane after its discharge from the uterus.

Hydrorrhœa Gravidarum and Decidual Endometritis.—Hydrorrhœa gravidarum is the term applied to a condition in which a discharge of watery fluid from the gravid uterus occurs intermittently in considerable amount, from the second or third month of pregnancy, and may continue to term. In some cases a small amount of blood is mixed with the watery fluid. It is a rare condition, and is often associated with fœtal malformation. Three possible sources for such a discharge may be pointed out. *Firstly*, it may be a leakage from the amniotic sac (hydrorrhœa amnialis); *secondly*, it may come from an adventitious collection of fluid between the chorion and amnion, resulting from imperfect fusion of these membranes; *thirdly*, it may come from the decidual space. In all probability the latter is the most common cause, and although it must be admitted that direct proof is wanting, decidual endometritis appears to offer the best explanation of the occurrence. A reference to Figs. 14 and 44 will recall the fact that in the lower part of the early gravid uterus there is a small cavity bounded on all sides by decidua, and termed the *decidual space*. In decidual endometritis a watery fluid such as that of hydrorrhœa may possibly be secreted, which accumulates in this space and is discharged from time to time through the cervix, when the amount becomes large. The existence of pockets of fluid in this position has been recently demonstrated by Duclos in the uterus of a woman who died during pregnancy, and who had suffered from hydrorrhœa with slight hæmorrhage. Normally the decidual space becomes obliterated by fusion of the decidua vera and decidua capsularis at the end of the fourth month, but when the membranes are unhealthy their fusion may be delayed or prevented; the decidual space may then persist and the hydrorrhœa continue until term. The expelling force may be considered to be uterine contractions of unusual power, reflexly excited by the presence of the accumulating fluid. The condition is not amenable to treatment of any kind, and is not of much clinical importance except when due to leakage of liquor amnii; it then leads to premature labour attended by many of the difficulties arising from ante-partum rupture of the membranes.

Diseases of the Membranes, Placenta, and Fœtus

Hydramnios (Synonym: Polyhydramnios).—This condition consists in the formation of an excess of liquor amnii. The amount of liquor amnii at term which may be regarded as normal varies considerably (p. 49); it is probable that only quantities exceeding 4 pints would be clinically recognisable as hydramnios. The fluid shows no abnormal characters, but it may attain the enormous bulk of 6 gallons.

The causation of hydramnios is by no means capable of simple explanation. It must be recollected that the condition is normal during the first eight weeks of gestation, and occurs in an exaggerated form in many cases of carneous mole. When occurring in the later months, it is occasionally associated with morbid maternal conditions such as dropsy from cardiac or hepatic disease, and more frequently with developmental anomalies of the fœtus. It is not clear, however, that these associations can be regarded as the cause of the hydramnios. In complete spina bifida escaping cerebro-spinal fluid may assist the accumulation of an excess of liquor amnii, but the amount of cerebro-spinal fluid is probably too small to make any serious difference.

It is quite possible that under normal conditions there may be both a formation and an absorption of liquor amnii, and hydramnios may therefore conceivably be brought about by deficient absorption as well as by excessive production. In some cases of hydramnios extreme torsion or thrombosis of the umbilical vein has been found; these conditions may lead to excessive transudation of fluid through the walls of the large vessels on the fœtal surface of the placenta. Whatever may be the precise mechanism of its production, certain considerations make it probable that hydramnios is usually due to a fœtal, not a maternal cause: (1) The mother is usually healthy; (2) the fœtus is frequently deformed, or shows some abnormality of development; (3) it frequently occurs in twin pregnancy, affecting only one amniotic sac; (4) the liquor amnii is certainly an embryonic product when first formed in the ovum. Hydramnios is more common in multiparæ than primigravidæ; in 75 per cent. of cases the fœtus is of the female sex; and it has been observed in extra-uterine gestation.

As usually met with, hydramnios is a *chronic* condition which does not become clinically recognisable until the fourth or fifth month of pregnancy, and is slowly progressive. Its actual onset is, of course, earlier than this. Occasionally, however, it assumes an *acute* form, an enormous quantity of fluid being formed within a few weeks. The symptoms to which it gives rise are due to the size of the uterus ; when the enlargement has occurred rapidly, as in the acute form, the symptoms are correspondingly severe ; in the chronic form much greater toleration of the large uterus is met with. Slight degrees of hydramnios usually escape recognition, especially if associated with twin pregnancy. The abdominal enlargement is often extreme, indeed hydramnios may yield one of the largest abdominal swellings ever met with. Relatively to the size of the abdomen, the associated symptoms are slight, consisting chiefly of some embarrassments of respiration and cardiac action, especially in the recumbent position, so that the patient must sleep well propped up in bed. There may also be pain and slight anasarca of the lower extremities, and, of course, inability for physical exertion of all kinds. There is no special tendency to the occurrence of albuminuria. Labour usually comes on prematurely, with ante-partum rupture of the membranes, which brings immediate relief.

The physical signs yielded by the uterus in a case of well-marked hydramnios differ from those of the normal gravid uterus as follows : (1) its size is disproportionately large ; (2) a fluid thrill may be obtained in all directions ; (3) sometimes the presence of the fœtus cannot be recognised either by palpation or auscultation ; (4) in slighter degrees the fœtal head may be felt, but not the trunk or the limbs. Signs of pregnancy will, however, be found in the active condition of the mammary glands (primigravidæ), the characteristic softening of the cervix, and a history of several months' amenorrhœa. These points should deter an observer from attributing the abdominal swelling to an ovarian cyst or to ascites. A large ovarian cyst may be occasionally associated with pregnancy ; the differential diagnosis from hydramnios is then more difficult, and will depend upon the recognition, in the former, of two distinct abdominal swellings together with the presumptive signs of pregnancy ;

the physical signs of one of the abdominal swellings will correspond with those of the normal gravid uterus.

There are no means known to us of controlling the production or absorption of liquor amnii, and this condition is therefore not amenable to treatment. If the pressure symptoms become severe, premature labour must be provoked, the method of choice being rupture of the membranes; this is more likely to be required in the acute than in the chronic form. The weakening of the uterine muscle from over-distension leads to uterine inertia and its attendant risks in labour (p. 443).

Oligo-Hydramnios.—In this condition the liquor amnii is deficient in amount, and there may be only a few ounces of fluid in the amniotic sac. Its causation is unknown, and it does not give rise to any maternal symptoms. The fœtus may show various deformities caused by amniotic adhesions.

Oligo-hydramnios may give rise to certain of the less important fœtal deformities through the insufficient space which it affords for free exercise of the limbs. In this way club-foot, spinal curvature, wry neck, or ankylosis of joints may conceivably be brought about. It is, however, by means of *amniotic adhesions* that still more important deformities are occasioned. These consist in the formation of intimate union between the amnion and some part of the skin of the fœtus; the result is the production of surface deformities in the affected parts.

Occurring upon the scalp, encephalocele may result; when surrounding a limb, strangulation followed by spontaneous amputation may occur; sometimes the adhesion may strangulate the cord, causing the death of the fœtus. Amniotic adhesions, while usually associated with deficiency of liquor amnii, sometimes occur when the amount of fluid is normal or is excessive.

Diseases of the Placenta.—Comparatively little progress has been made with the study of the morbid conditions of the placenta, for the reason that the normal structure of the organ at different periods of gestation has only recently been systematically worked out. Most of the earlier accounts of placental diseases must be rejected because the writers were ignorant of these fundamental details. Thus 'placentitis' was at one time thought to be a lesion of frequent occurrence,

but it is now known that inflammation rarely, if ever, occurs in the placenta; again, conditions such as 'infarctions,' which were once regarded as syphilitic gummata, are now known to be non-syphilitic.

Anomalies of Size and Shape.—The placenta is sometimes divided unequally into lobes or segments, which are united by large vessels (umbilical) running in the membranes which connect them. There may be two lobes (*placenta bipartita*) (Fig. 68), three lobes (*placenta tripartita*), or more than three

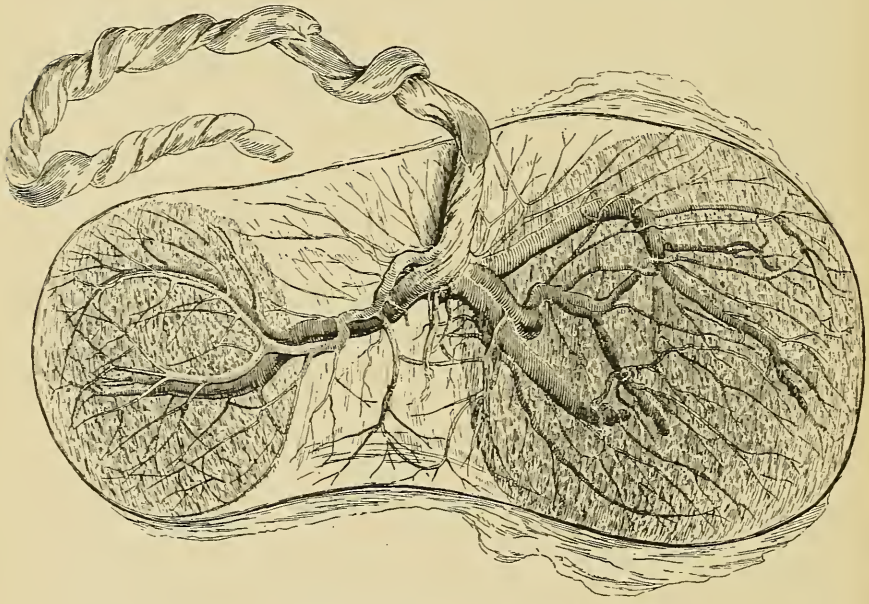


FIG. 68.—Placenta Bipartita.
Note the bifurcation of the umbilical vessels at the point of insertion of the cord.

(*placenta multiloba*). More important than these is another variety of divided placenta, called the *placenta succenturiata* (Figs. 69 and 55). In this form one or two small outlying portions of placenta, circular or oval in shape, are present; they are connected with the main placenta by small vessels running in the membranes, and are very liable to be left in the uterus after labour; they may thus give rise to post-partum hæmorrhage, and (indirectly) in the puerperium to septic troubles. Very rarely the placenta is formed over the whole area of the chorion, the usual differentiation into

chorion frondosum and chorion læve not taking place. This is known as the *placenta diffusa :* it is the natural form in certain animals—*e.g.*, the sow and the mare.

Anomalies of the Umbilical Insertion.—The cord is usually attached to the placenta about its centre ; but the

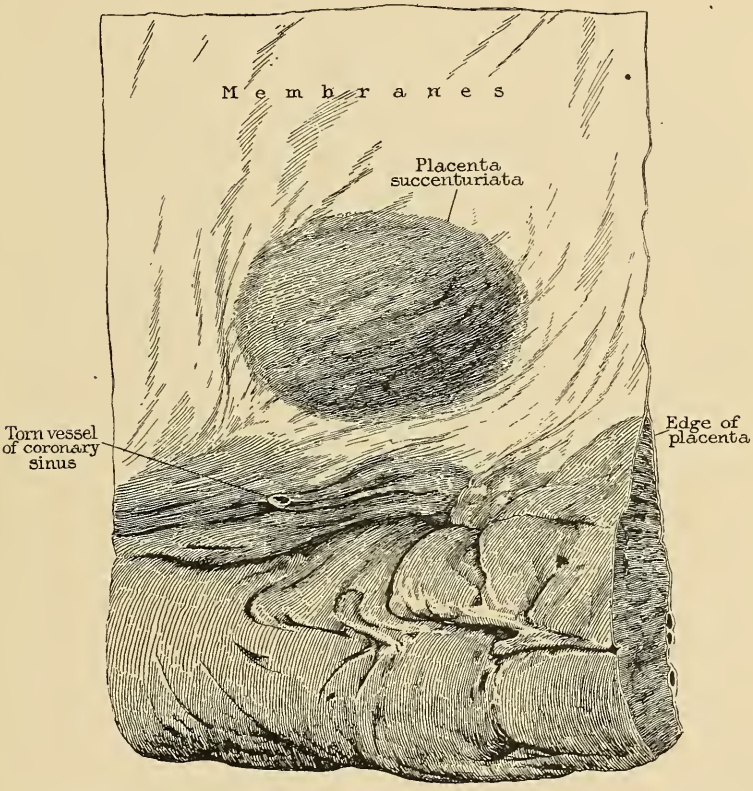


Fig. 69.—A Portion of Placenta and Membranes, showing a Small Placenta Succenturiata. (Charing Cross Hospital Museum.)

insertion may be excentric, lateral, or marginal, the latter being called the *battledore placenta* (Fig. 70). More important practically is the comparatively rare anomaly of the insertion of the cord into the membranes altogether outside the placental margin—the *velamentous placenta* (Fig. 71). Very large vessels, constituting the primary divisions of the umbilical arteries and vein, then run beneath the amnion,

from the point of insertion to the placental margin, and are liable to become injured during labour by compression, or by rupture of the membranes which enclose them. The latter accident is only liable to occur when these vessels are

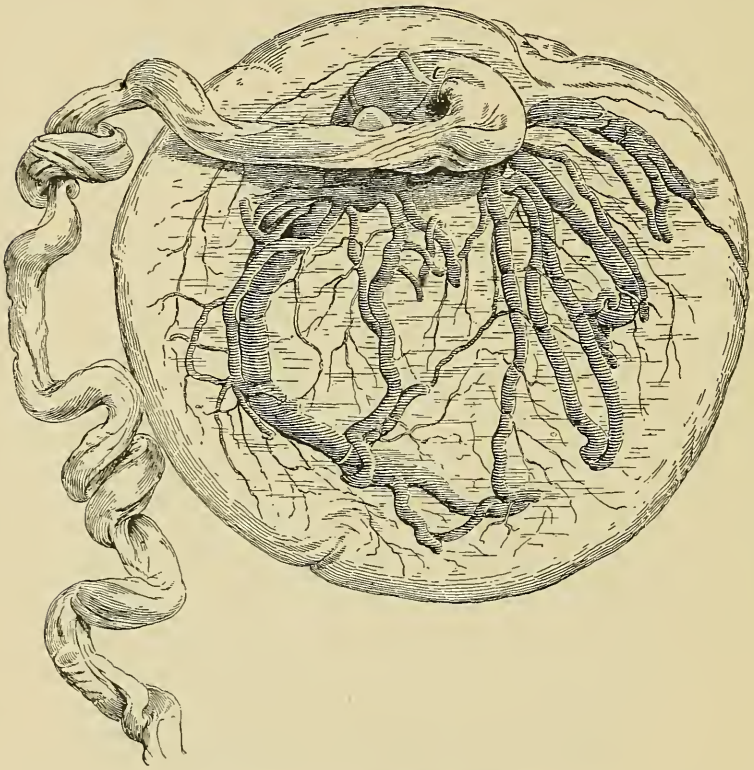


Fig. 70.—Battledore Placenta.

The umbilical cord is inserted close to the placental margin.

situated in the position where the membranes rupture at the end of the second stage of labour.

Placental anomalies cannot, as a rule, be recognised until after delivery. An exception to this rule is the case of the velamentous insertion which may be recognised during labour if the vessels chance to cross the lower pole of the ovum. A case of this kind has been recorded by Williamson, in which he delivered the child by Cæsarean section, in order

to avoid the risks of fatal fœtal hæmorrhage when the membranes ruptured.

Pathological Infarction of the Placenta.—It has been already stated that, during the last two months of intra-

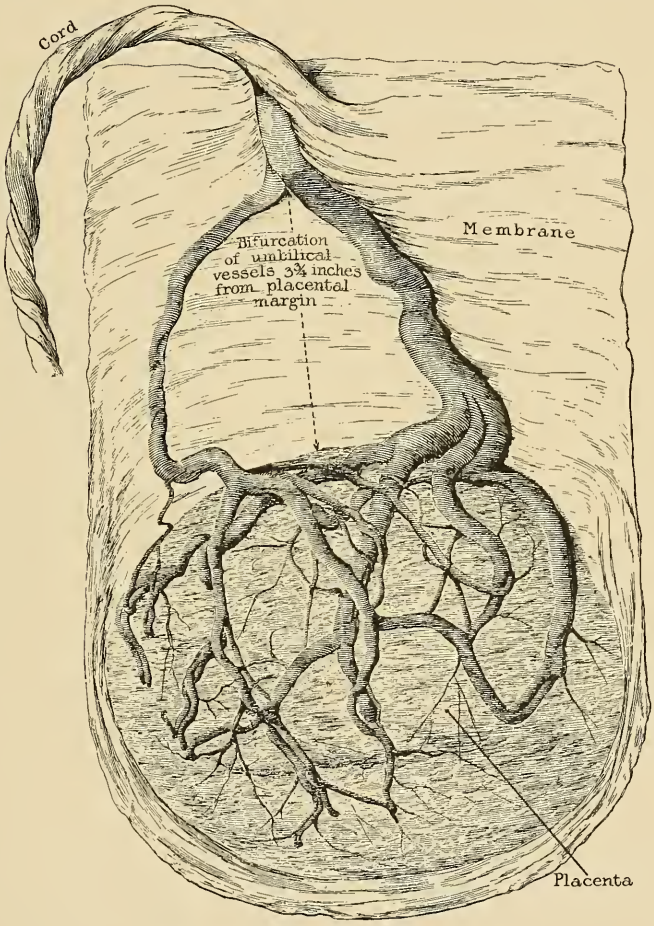


Fig. 71.—Velamentous Placenta.
The amnion has been stripped off.

uterine life, certain age-changes occur in the fœtal portion of the placenta which result in the formation of small solid bodies, termed ' infarcts,' in the spongy placental substance (p. 45). In connection with the albuminuria of pregnancy, and with chronic nephritis in pregnancy, changes of a similar

nature, but much more extensive, and occurring earlier in gestation, are met with. These changes are probably important factors in the causation of the heavy fœtal mortality which attends these disorders. In such cases recent hæmorrhages into the placental substance are also often found, and are probably due to rupture of vessels in the decidua.

Degeneration of the Placenta.—Fatty, calcareous, and cystic degenerations are often met with in the placenta. Fatty and calcareous degenerations are usually combined, and are constantly found in infarcted areas ; it is probably true that primary fatty degeneration does not exist in the placenta, and in no circumstances is it directly related to syphilis. Extensive calcareous degeneration of the uterine surface of the placenta is common when gestation has been unduly prolonged (post-maturity). Cystic degeneration results in the formation of small sub-amniotic cysts upon the fœtal surface of the placenta. They are frequently multiple ; they are never large, and do not affect the functional activity of the organ. Hydatidiform degeneration has been already described.

Tubercle of the Placenta is very rare, but it has been shown to occur occasionally in women affected with acute general tuberculosis or advanced chronic phthisis. The tuberculous deposits may be found either in the decidua, upon the chorionic epithelium, or in the stroma of the villi. Caseation is frequently found in these deposits, and in cases of acute maternal tubercle, miliary deposits may be widespread in the fœtal portion of the placenta. It appears that there is not much probability of placental infection except in advanced cases.

Solid Tumours of the Placenta are extremely rare, the greater number of those described being myxo-fibromata.

Hæmorrhage and *Œdema* also occur in the placenta. We know little of the causation of the former ; the latter is always associated with general œdema of the fœtus—one of the rarest varieties of intra-uterine disease.

Placental Syphilis.—In 1873 Fränkel endeavoured to prove that definite syphilitic lesions occurred in the placenta ; that the disease appeared in the chorionic villi when the father was infected, and in the decidua when the mother was infected. Syphilitic villi he described as of unusually large

size from proliferation of the connective-tissue stroma, with obliterated vessels, and extensive fatty degeneration of all the tissues. The decidua he described as thickened from hyperplasia. His conclusions have been traversed by many observers, and have never been satisfactorily confirmed.

The question has entered upon an entirely different phase since the discovery of the specific organism of syphilis by Shaudinn—the *spirocheta pallida*. The presence of this organism must now be regarded as conclusive proof of the disease, and as it has been demonstrated in the placental tissues by numerous observers, the occurrence of syphilitic disease of the placenta is unquestioned. The organism is found mostly in the fœtal portion of the placenta, and is distributed especially around the vessels running in the stroma of the villi; this corresponds with the position in which the organism is found in the case of chancres. When present in the placenta it can also be readily demonstrated in the fœtal viscera, especially the liver.

Placentæ infected with syphilis are usually abnormally large and heavy; the latter point is of considerable practical importance, for the great majority of placentæ which exceed the normal limits of weight are syphilitic. In appearance the placental tissue is pale, the cotyledons are voluminous, and the sulci between them abnormally deep. Microscopically the only definite change observed in most instances is that the villi are abnormally large, the increase being due to excess of the connective-tissue stroma, which, however, is not otherwise abnormal. In this respect the views of Fränkel have therefore been confirmed.

Abnormal Conditions of the Fœtus.—The fœtus may be the subject of many abnormal conditions, arising from disease or from errors of development. In a certain number of instances disease is transmitted from one or other parent, usually the mother; in others disease arises spontaneously in intra-uterine life. Very few of these abnormal conditions are of clinical importance. A certain number of developmental errors, however, give rise to difficulty in labour, and will be referred to again in that connection; among these may be mentioned double monsters, hydrocephalus, ascites, abdominal tumours (usually cystic), and general dropsy. Abnormalities of development do not, as a rule, influence

the course of pregnancy. The following microbial diseases have been shown to be capable of transmission from the mother to the fœtus: *enteric fever, cholera, yellow fever, cerebro-spinal meningitis, pertussis, variola, scarlatina, malaria, morbilli, erysipelas,* and *syphilis* (Ballantyne); the appearances characteristic of these diseases may be present at birth, or may arise after delivery if the child survives. Further, in the case of *tubercle, anthrax, erysipelas, sepsis,* and *diphtheria,* the specific organism has been found in the fœtal tissues, but not the local lesions characteristic of these diseases in the adult; strictly speaking, the last-named diseases are therefore not transmitted, the cause of the death of the fœtus under such circumstances being probably septicæmia. Syphilis may be transmitted from either parent; usually, however, it is paternal in origin. The following are the chief signs of fœtal syphilis as seen in a fœtus which has perished from this disease *in utero:* a bullous eruption (pemphigus), seen especially upon the palms and soles; gummata in the liver and spleen; and in the long bones hyperplasia of the cartilaginous elements along the line of junction of the shaft with the epiphysis—so-called *syphilitic epiphysitis.*

EXTRA-UTERINE (ECTOPIC) GESTATION

It is now well established that a fertilised ovum may become implanted not only in the uterus, but in the Fallopian tube or in the ovary; in the two last-named positions the pregnancy is called extra-uterine or ectopic.

The possibility of the implantation of a fertilised ovum upon the peritoneum—*primary peritoneal pregnancy*—has been much discussed, but until the last year or two it cannot be said to have been satisfactorily demonstrated. Blair Bell now claims to have shown that it may occur in rodents, and consequently its occurrence in the human species cannot be regarded as impossible. Further, a case has recently been recorded by Gröné (Sweden) which he asserts to be one of primary peritoneal pregnancy, the ovum having been implanted upon the peritoneum immediately behind the right round ligament. The case was submitted to operation, and as the patient recovered a detailed histological examina-

tion of the uterus and Fallopian tubes was not made. While there can be no inherent impossibility about the occurrence of primary peritoneal pregnancy, its actual demonstration is beset with great difficulties, and there can be no question that if it occurs at all in women it is very much rarer than the other two varieties of ectopic pregnancy.

OVARIAN PREGNANCY

It is only within recent years that the occurrence of ovarian pregnancy has been satisfactorily proved, but the number of cases which can be accepted as reliable instances of the condition is now fairly large. There can be no doubt that it is very much less frequent than tubal pregnancy. In most cases the site of implantation appears to have been a Graafian follicle, which may be entered by spermatozoa through the site of rupture, or possibly by direct penetration of the wall. It is, however, possible that the ovum may be impregnated when lying upon the surface of the ovary after its discharge from the follicle, and may afterwards excavate a bed for itself in the ovarian tissues by its remarkable powers of erosion. Generally, however, the spermatozoa enter a Graafian follicle, and fertilise an ovum therein which has not been discharged along with the fluid contents of the follicle. In the cells which line the follicle the ovum finds its nidus, and the early stages of development pursue the usual course. Fig. 72 shows that the gestation sac, or maternal covering of the ovum, is very thin, and consists simply of thin layers of ovarian tissue in which some of the villi are imbedded ; the base of the ovum rests upon the main portion of the ovary. There is no decidual membrane formed in ovarian pregnancy, although certain large cells have been found by some observers and described as decidual.

The great majority of cases of ovarian pregnancy have terminated by rupture at an early period of gestation. Some, however, have progressed up to or beyond the mid-term. An interesting example has been recorded by McCann in which pregnancy continued for five and a-half months, the sac being apparently on the point of rupture when the operation was performed. In this case, the gestation was situated in the functionally active part of an ovary, which

was already the seat of a cystic tumour. A considerable number of cases of reputed ovarian pregnancy at term have been recorded, but in most instances the evidence of their exact nature is inconclusive.

Ovarian pregnancy cannot be distinguished by *clinical* methods from tubal pregnancy ; questions of diagnosis and treatment are therefore identical with those of the latter

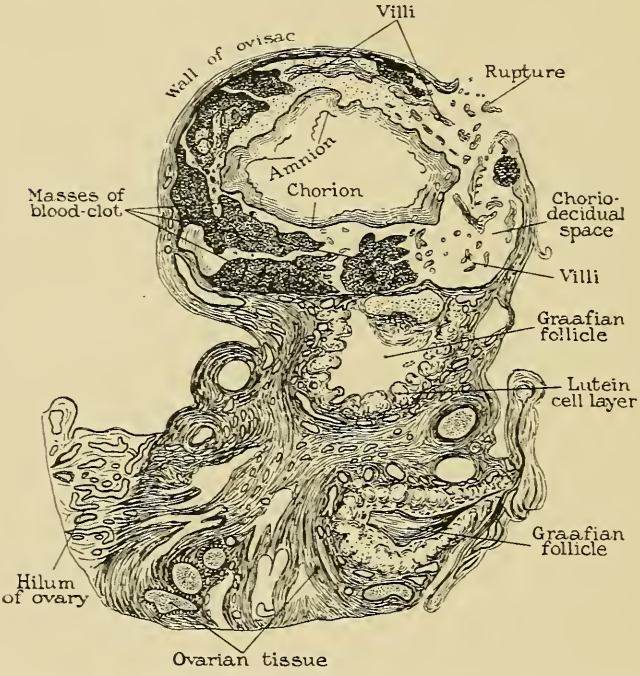


FIG. 72.—Ovarian Pregnancy (Van Tussenbrock). The Ovum has developed in a Graafian Follicle ; Rupture has occurred on the free surface of the Gestation-Sac.

condition. The *anatomical* diagnosis of an ovarian pregnancy is to be made chiefly by careful attention to its relations *in situ*, which must be those of the normal ovary. Further, ovarian tissue must be recognisable on microscopic examination in several parts of the gestation sac, showing that the ovary has been expanded by its growth. The histological elements which are characteristic of ovarian tissue, are Graafian follicles, corpora lutea, and in the absence of definite yellow bodies, clusters of lutein cells.

Its differential diagnosis by clinical methods from tubal pregnancy is impracticable in the present state of our knowledge, careful examination of the complete specimen, after removal, being required to determine its true nature.

TUBAL PREGNANCY

The lodgment of a fertilised ovum in the Fallopian tube is not uncommon. The causes of the arrest of the ovum in the tube on its journey to the uterus are probably not pathological, most of the older explanations having been disproved or abandoned from lack of supporting evidence. It is known, however, that diverticula of the tubal canal are sometimes found running up into the fibro-muscular wall of the tube ; it is possible therefore, that an ovum, either before or after being fertilised, may wander into one of these *impasses* and, being detained there, may become engrafted upon the mucous membrane, which has the same structure as that of the tube proper. And further, the anatomical arrangement of the tubal mucosa is such that the ovum may readily become detained among the complex ramifications of the tubal plicæ in the outer portion of the canal. The view that arrest of the ovum in the tube may be due to such morbid conditions as salpingitis, or partial occlusion of the tubal lumen by adhesions, has not received support from morbid anatomy, and must be abandoned. Age and social condition do not influence its occurrence ; it may be met with in a first or in any subsequent pregnancy, and in the latter case it may follow normal gestation after an interval varying from a few months to many years. Tubal pregnancy is in all probability to be regarded as an accidental occurrence ; it is a morbid condition only in the sense of involving both the mother and the ovum in serious risks. Consequently gravid tubes are usually healthy at the time of the occurrence of gestation (Fig. 77) ; in some cases, however, evidences of chronic salpingitis are found, showing that this condition sometimes precedes the gestation (Fig. 76).

Anatomy.—Tubal pregnancy gives rise to a series of well-marked changes in the uterus, and in the affected Fallopian tube ; the former are uniform and constant, the latter vary with the location of the ovum. The *uterus*

always shows a certain amount of enlargement, accompanied with softening of its walls and softening of the cervix ; both are recognisable clinically, although the softening of

Fig. 73.—Section through a Gravid Fallopian Tube, illustrating the formation of a Tubal Mole (Whitridge Williams). *V*, Villi which have penetrated deeply into the wall of the tube, probably indicating the original implantation site; *b.c.*, Blood-clot containing chorionic villi seen in section: in the centre of the mass is an irregular space representing the amniotic sac.

the lips of the external os is not so well marked as in uterine pregnancy. The size of the uterus seldom exceeds that of two and a-half months gestation. The endometrium is completely converted into a decidual membrane indis-

tinguishable from the decidua vera of normal uterine pregnancy. This change has been spoken of by Webster as the 'decidual reaction' of the uterus. In the affected *tube* the changes are mainly confined to the neighbourhood of the ovum, distant parts showing practically no changes recognisable with the naked eye. No true formation of a decidua occurs in the tube, although it has been demonstrated that clusters of large 'decidual' cells may be found here and there in the mucous membrane of both the affected and the unaffected tube. The portion of the tube which encloses the ovum is usually called the *gestation-sac*.

The fertilised ovum lodges most frequently in the *ampulla* of the tube, more rarely in the *isthmus*, and least frequently of all in the *interstitial* portion. It has been clearly shown that, when lodged in the tube, the fertilised ovum buries itself in the maternal tissues very much in the same manner as in uterine pregnancy. The mucous membrane undergoes no preparatory thickening as does the endometrium; penetration of the tissues is easy, and there appears to be no doubt that the ovum actually reaches the muscular coat and becomes completely imbedded in it. The ovum thus develops, for a time at any rate, in a cavity hollowed out of the substance of the tube-wall and practically shut off from the tube-lumen. This arrangement compensates, to some extent, for the absence of a complete decidual investment, and renders the early lodgment of the ovum more secure. The formation of the embryo and of the embryonic coverings proceeds in the same manner as in uterine pregnancy. At the site of the growing ovum the tube undergoes rapid distension and assumes a somewhat oval form. The wall of the distended portion becomes considerably thinned; this thinning is due in part to the absence of compensatory muscular hypertrophy, such as takes place in the gravid uterus, and in part to the eroding action of the chorion, which penetrates the tissues, and still further thins the wall. When the ovum lodges in the ampullary portion the abdominal ostium almost invariably becomes occluded before the end of the second month (eighth week); when the ovum lies in the isthmus or the interstitial portion the abdominal ostium does not close (Fig. 77). The condition of the ostium, as will appear later, has an important clinical bearing. A

gravid tube is usually found, on opening the abdomen, to have contracted adhesions to surrounding structures ; and at spots where the penetrating villi have reached, or nearly reached, the peritoneal coat, thick layers of lymph become deposited, the effect of which is to strengthen the weak spot.

From this account it is obvious that the ability of the Fallopian tube to continue to accommodate the growing ovum is by no means certain ; as a matter of fact it fails to do so except in extremely rare instances. It is, however, believed that genuine cases are on record of gestation continuing to term, or nearly to term, in an unruptured Fallopian tube. Failing this event, either the ovum is destroyed, or it escapes from its cramped surroundings and pursues its development under more favourable conditions. The ovum may be destroyed *in situ* by hæmorrhage which converts it into a *tubal mole ;* or it may be detached from its base and expelled either through the patent abdominal ostium (*tubal abortion*), or through a rent in the wall of the tube (*tubal rupture*). In some instances rupture occurs without causing complete detachment of the ovum ; its existence is not then necessarily terminated, for development may proceed in the freer space thus gained for it.

The Tubal Mole.—The mode of formation of a tubal mole is well shown in Fig. 73, which represents a transverse section through a gravid Fallopian tube at the site of implantation of the ovum. The lumen of the tube is occupied by an oval mass of blood-clot detached completely from the wall ; a cavity of irregular shape, representing the amniotic sac, is seen, placed somewhat excentrically in the midst of the blood-clot. The effect of the hæmorrhage has clearly been to break up the chorion, which at this early period is covered in all parts with villi ; many detached villi are seen in section in the blood-clot surrounding the ovum ; a few are seen still retaining their attachment to the ovum, others are seen to be buried in the tube wall and to be broken off entirely from the ovum. There is no appreciable thinning of the wall of the tube except at the right of the figure, where chorionic villi can be seen to have penetrated nearly as far as the peritoneal investment, thus breaking up the muscular wall of the tube. This spot probably represents the pit in which the ovum was originally imbedded. Remains of the

branching plicæ of the tubal muscosa are also seen flattened out against the tube wall, which indicate that the ovum has lodged in the ampullary portion of the tube. In Fig. 74 are seen the naked-eye appearances of a tubal mole *in situ*

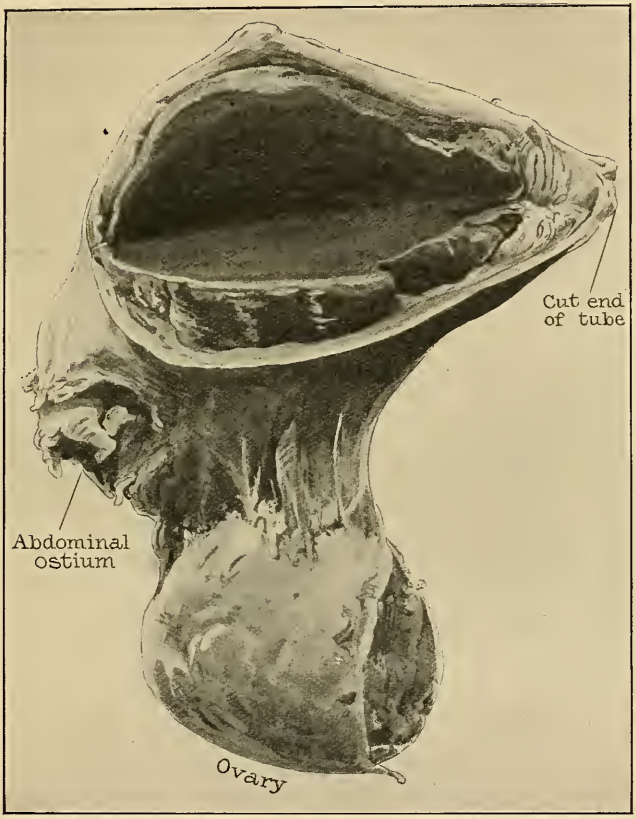


FIG. 74.—Tubal Mole *in situ*, Laid Open by Longitudinal Incision of the Tube (Charing Cross Hospital Museum). The mole occupies the inner half of the ampullary portion of the tube. The abdominal ostium is patent.

laid open by longitudinal section ; the tube was removed on account of hæmorrhage through the unsealed abdominal ostium.

The statement is made by Bland-Sutton that ' a tubal mole is due to blood extravasated from the circulation of the embryo.' This opinion rests solely upon the observation by

this author of the occurrence in the tubal mole of nucleated red blood-corpuscles such as are found in the blood of the embryo, but not in that of the adult. In reality all that this observation proves is that there is in the mole an admixture of embryonic blood ; but it cannot be supposed that tubal

FIG. 75.—Chorionic Villi from a Tubal Mole. The large imbedded villus is seen to have lost its epithelial covering; its stroma contains very few nuclei. The free villi have preserved their epithelium, which consists of a double row of cells. Syncytial buds in section are seen in the upper part of the figure.

moles, which are much larger and heavier than the embryo, can be formed by extravasation of embryonic blood alone. There is no doubt that they consist almost entirely of maternal blood, which has been extravasated from the tube wall among the villi.

In tubal pregnancy the frequency with which moles occur

is far greater than in the case of uterine pregnancy, probably on account of the greater insecurity of the ovuline attachments in the former. The formation of a mole is frequently accompanied by more or less hæmorrhage through the unsealed abdominal ostium. The ovum is of course destroyed by this process; small moles may, perhaps, be retained in the tube and gradually disposed of by absorption; larger moles are usually expelled by tubal rupture or abortion. Suppuration of a mole retained in the tube probably

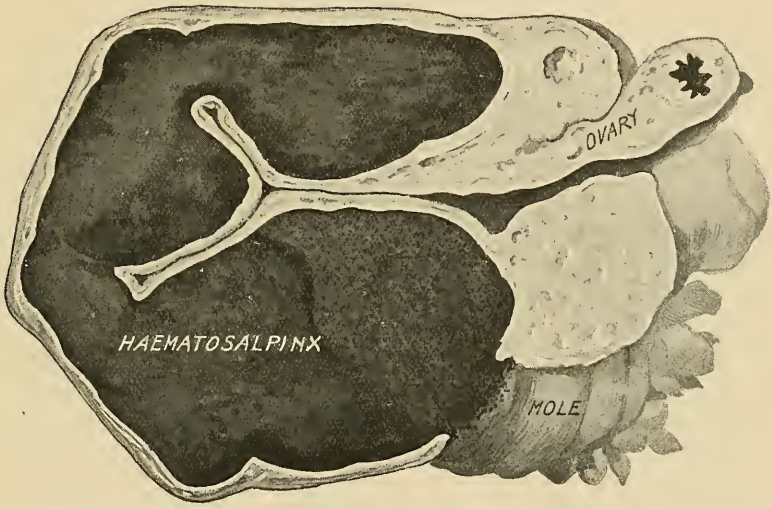


Fig. 76.—Tubal Pregnancy terminating in Abortion. The tubal mole is seen partly extruded through the abdominal ostium. The tube is convoluted and its walls thickened from chronic salpingitis; its lumen is dilated and full of blood.

only occurs as the result of some form of infection, such as sepsis, gonorrhœa, or bowel-infection.

In operating on cases of tubal gestation a mole is frequently found among the blood effused into the peritoneal cavity by rupture or abortion; it exactly resembles a lump of blood-clot, and may remain unnoticed unless carefully looked for. Small moles are nearly globular (Fig. 77); larger ones are oval in shape, heavier and firmer than simple clotted blood (Fig. 74); they often show remains of the amniotic sac on section, and on microscopic examination,

after suitable hardening, are found to contain chorionic villi imbedded in clotted blood.

The recognition of chorionic villi under these conditions is a matter of some clinical importance. As shown in Fig. 75, some are free, others imbedded in the blood-clot. The former are covered by epithelium, definitely recognisable as that of the chorion, since it is composed of two layers—the outer layer consisting of irregularly nucleated plasmodium (the syncytium), the inner layer consisting of a single row of low columnar cells (Langhans' layer). The latter have almost completely lost their epithelium, while the stroma of all the villi has undergone considerable degeneration and appears structureless. The epithelium retains its vitality for a longer period after the destruction of the ovum than the stroma ; this difference is due to the fact that the former is normally nourished directly by the maternal blood with which it is always in contact, while the latter is normally nourished by the blood in the fœtal capillaries. The epithelium can therefore draw nourishment from the effused blood in a mole, and thus survive, while the stroma, being suddenly cut off from its source of nutrition, perishes with the embryo. Owing to survival of the epithelium, villi can be recognised in a mole many weeks after its formation. Around the villi is seen blood-clot, in varying degrees of contraction—*i.e.*, with a variable amount of fibrinous network. Sometimes quite fresh-looking villi may be found in a recent tubal mole.

Tubal abortion occurs frequently in ampullary pregnancy while the abdominal ostium remains patent—*i.e.*, during the first two months of gestation ; it is believed that it occurs almost as commonly as rupture in this variety of tubal pregnancy. In the isthmial and interstitial varieties, however, rupture is much more frequent than abortion ; in the latter variety tubal abortion consists in the discharge of the ovum through the uterine ostium into the *uterine* cavity. An aborted tubal ovum, as a rule, has been previously converted into a mole, but this is not always the case. The first step in the process of tubal abortion is the separation of the ovum from its attachments. We have seen that as a rule the ovum develops within the tube wall, not in the lumen of the canal. At the site of implantation the lumen is distorted and compressed by the pressure of the growing

ovum. At some point the tubal investment gives way and the gestation sac ruptures into the lumen of the tube ; this forms the first step in the occurrence of a tubal abortion. Berkeley and Bonney described this process as ' intra-tubal rupture ' to distinguish it from ' tubal rupture ' in which the sac opens into the peritoneum or the broad ligament (*vide infra*).

The actual process of abortion is seen in Fig. 76, which shows that the mole has been partly expelled through the dilated abdominal ostium. The main factor in its production is undoubtedly muscular contraction of the unaffected

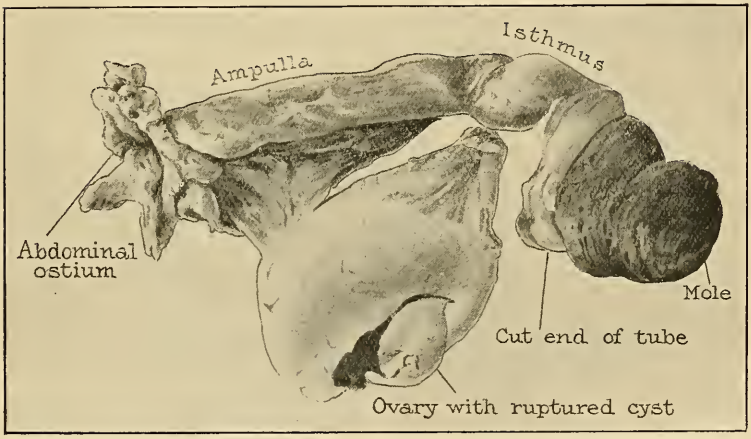


Fig. 77.—Tubal Pregnancy of Four to Five Weeks' Duration. Rupture has occurred in the isthmial portion of the tube and a small mole has been extruded. The abdominal ostium is patent, and the ampullary portion shows little alteration.

portions of the tube ; the process constitutes a miniature labour, consisting of a stage of dilatation followed by a stage of expulsion, which again is succeeded by a stage of retraction. The developmental unity of the uterus and Fallopian tubes no doubt accounts for this physiological analogy. The contractions are perhaps reflexly excited by hæmorrhage, causing sudden distension of the tube. The expulsion of the ovum may be complete or incomplete ; in the latter the ovum is detained in the insufficiently dilated abdominal ostium, or a portion of it may remain attached to the original implantation site of the ovum, the bulk of which has been expelled. Here again the analogy with uterine abortion will

be obvious. Tubal abortion may be attended by severe internal bleeding, equal in severity to that caused by rupture; its result as regards the ovum is invariably to destroy it. After the expulsion of the ovum the tube usually remains considerably distended with blood (Fig. 76), but it is believed that it may rapidly retract and resume its normal shape and calibre, leaving no trace to the naked eye of having been recently gravid. It is impossible to distinguish tubal abortion from tubal rupture by clinical diagnosis.

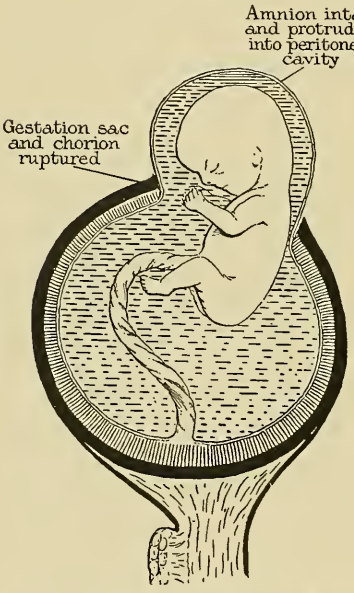


Fig. 78.—Intra-Peritoneal Rupture of the Tube (diagrammatic; after Giles). The chorion has been torn, but the amnion remains intact, the fœtus contained within it; the placental portion of the chorion is uninjured. The fœtus may survive.

Tubal Rupture. — In whatever part of the Fallopian tube the fertilised ovum may be lodged, there is a tendency to the occurrence of spontaneous rupture. In the isthmial and interstitial varieties rupture is apt to occur earlier than in the ampullary variety, owing to the fact that the latter is larger and more distensible than either of the former. Between the eighth and tenth week is the commonest time for rupture to occur, but it may be earlier or later than this. The conditions which predispose to rupture have been mentioned—viz., thinning of the tube wall by distension and the eroding action of the villi. In addition, there is probably a determining cause in most instances, such as a sudden increase in size of the ovum from hæmorrhage, or slight increase in vascular tension from some muscular effort on the part of the patient. Occasionally the eroding action of the villi alone will determine spontaneous perforation of the wall of the tube. Occlusion of the abdominal ostium is not

an essential factor in the causation of rupture, for this accident frequently occurs without it, even in the ampullary variety. Any part of the wall of the distended portion of the tube may burst.

The results of rupture, in so far as the life of the *ovum* is concerned, depend to a great extent upon the position of the rent. If occurring upon the roof or sides of the tube, the

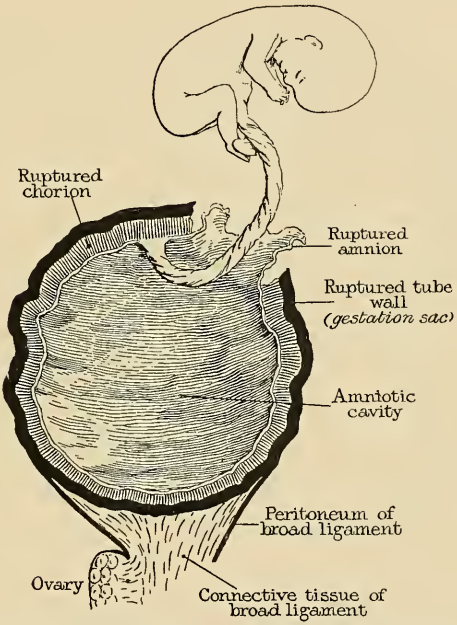


FIG. 79.—Intra-Peritoneal Rupture of the Tube (diagrammatic; after Giles). The chorion and amnion have both been torn, and the fœtus has escaped from the gestation sac; the placental portion of the chorion is injured. The fœtus will perish.

rupture will involve the peritoneal covering, and the blood effused will therefore be poured out into the general peritoneal cavity, while the mole may be completely expelled through the rent (Fig. 79). If, on the other hand, the tear takes place in the floor of the tube, the peritoneal coat may escape, while the effused blood and the discharged ovum will make their way between the layers of the broad ligament, gradually separating them and burrowing in the connective

tissue which this ligament contains (Figs. 80 and 81). This form of rupture is very uncommon and occurs mainly in cases of isthmial pregnancy, since the lower wall of this portion of the tube is less completely invested by peritoneum than the ampulla. The former is known as *intra-peritoneal* rupture, the latter as *intra-ligamentary* or *extra-peritoneal* rupture. In both varieties the ovum is, as a rule, destroyed by previous hæmorrhage and converted into a mole. Apart

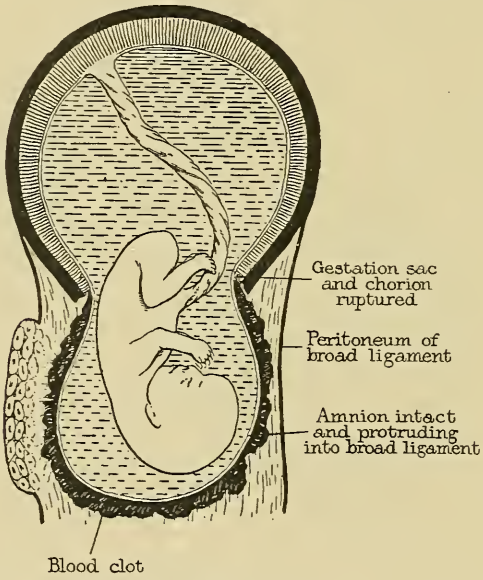

Gestation sac and chorion ruptured
Peritoneum of broad ligament
Amnion intact and protruding into broad ligament
Blood clot

FIG. 80.—Intra-Ligamentary Rupture of the Tube (diagrammatic; after Giles). The amnion and the placental portion of the chorion are uninjured. The fœtus may survive.

from hæmorrhage, pregnancy almost invariably comes to an end (*a*) if the amnion is ruptured, or (*b*) if the placental portion of the chorion is lacerated or detached by the rupture (Figs. 79 and 81). Occasionally, however, the ovum may continue its development, and in such cases it is observed that the amnion has remained intact, and that the placental chorion was so situated as to escape injury from the rupture (Figs. 78 and 80). In intra-peritoneal rupture the placenta then grows out of the rent and becomes attached to the neighbouring peritoneal surfaces, while layers of lymph are

deposited upon the exposed amnion from the surrounding peritoneum, forming a false membrane which constitutes a secondary gestation sac. This secondary sac becomes further strengthened by adhesion to the neighbouring peritoneal surfaces, including omentum, coils of intestine, and the abdominal parietes. The ovum is now known as a *secondary abdominal* (*intra-peritoneal*) *pregnancy*. Precisely similar results may follow extra-peritoneal rupture, and

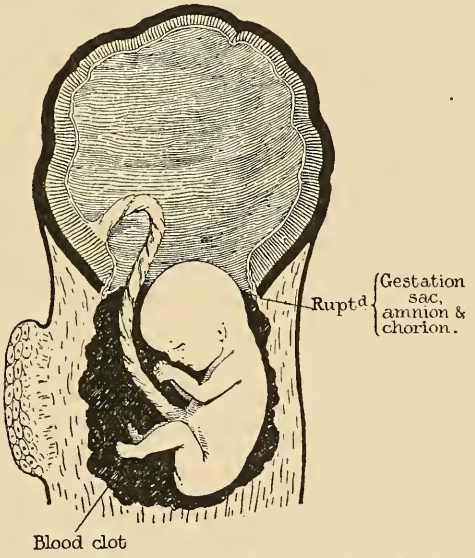


FIG. 81.—Intra-Ligamentary Rupture of the Tube (diagrammatic; after Giles). The chorion and amnion have both been torn, and the placental portion of the chorion is injured. The fœtus will perish. Bleeding is intra-ligamentary.

for the same reasons; the condition is then described as *secondary abdominal* (*intra-ligamentary*) *pregnancy* (Fig. 80). Of intra-ligamentary pregnancy two varieties are described. In the *anterior* variety the ovum in its growth raises the anterior peritoneal layer of the broad ligament, and strips the peritoneum from the abdominal wall. When fully developed, such a gestation sac may be incised and evacuated without entering the peritoneal cavity at all. In the *posterior* variety the posterior layer of the broad ligament and the floor of the pouch of Douglas are elevated by the

growth of the fœtus, and the sac can then only be reached by a trans-peritoneal operation. Both intra-peritoneal and intra-ligamentary pregnancy may continue to term; the patient then usually passes through a 'false labour,' and the fœtus perishes. The occurrence of this false labour is a physiological point of great interest and importance, but we have no information as to its causation, or the mode in which it leads to the death of the fœtus. False labour is attended with severe abdominal pain, which is mistaken by the patient for labour, but there is no clinical evidence that uterine contractions play any part in its production. Intra-ligamentary pregnancy may undergo *secondary rupture* into the peritoneal cavity; even then the ovum is not in all cases destroyed, but may continue as an intra-peritoneal pregnancy.

In the intra-peritoneal form of secondary abdominal pregnancy the gestation sac consists of a membrane which is largely inflammatory in origin, and is composed of layers of lymph deposited upon the amnion, in which organisation has proceeded to a variable extent. This membrane becomes closely adherent internally to the amnion, externally to the abdominal walls, and to the viscera, which structures support it and add to its strength. A great deal of the placental blood supply is obtained from adherent omentum and mesentery.

In the intra-ligamentary form the gestation sac consists of the tissues composing the broad ligament, which are progressively expanded as the fœtus grows. This process involves great changes in the anatomical relations of the parts. Thus the peritoneum is raised from the pelvis, and stripped off the anterior abdominal wall, so that the reflection which corresponds to the floor of the utero-vesical pouch may exceed the height of the umbilicus (anterior variety), or the level of the pouch of Douglas is raised, and the mesentery of the colon on either side may be opened up and stretched over the gestation sac. An incidental result of these changes is that in such cases the sac may be opened by an abdominal incision without traversing the peritoneal cavity at all (anterior variety).

Many cases are on record, both in ancient and in modern times, in which an extra-uterine fœtus has been retained

within the abdominal cavity for many years after its death. In some of these cases the gestation sac has become infected from the bowel or the uterus, and suppuration has occurred, resulting in the formation of fistulous communications with the exterior, or with the neighbouring hollow viscera—large intestine, bladder, and vagina. Through these fistulæ fœtal bones are from time to time discharged. When, however, the sac remains free from infection the body of the fœtus shrinks by absorption of its fluid constituents, and upon the dried tissues lime-salts become freely deposited, converting it into a *lithopœdion*. In this condition it may be retained for many years with little disturbance to the patient.

Clinical Features of Tubal Pregnancy

This subject will be considered in relation to three stages : (*a*) before the occurrence of internal hæmorrhage, (*b*) after that occurrence, (*c*) in secondary abdominal pregnancy.

(*a*) **Before the Occurrence of Internal Hæmorrhage.**—At this time tubal pregnancy gives rise to little more local or general disturbance than does an early pregnancy in the uterus. An important symptom often associated with this phase—namely, a brief period of amenorrhœa—is a most useful aid in diagnosis, but it is by no means always present. When a healthy adult woman, who is usually regular, goes for two or three weeks over the expected date of her period, there is a strong presumption of pregnancy, but at this time there may be little to indicate whether pregnancy is uterine or extra-uterine. In the latter case, however, amenorrhœa is of very brief duration, seldom more than seven or eight weeks ; it then gives place to hæmorrhage. In something like 30 per cent. of cases there is no interruption of menstruation at all, and therefore while amenorrhœa forms a useful positive indication, no importance whatever can be attached to its absence. Recurrent attacks of abdominal pain on the same side as the gravid tube are often met with, and are probably due to tubal distension. As it is quite unusual for an extra-uterine gestation to continue undisturbed beyond the end of the second month, there is no time

for the appearance of other general symptoms of pregnancy. But occasionally morning sickness and early breast changes may be met with.

The *unruptured gravid tube* forms an elastic swelling lying as a rule posteriorly or postero-laterally to the uterus (Fig.

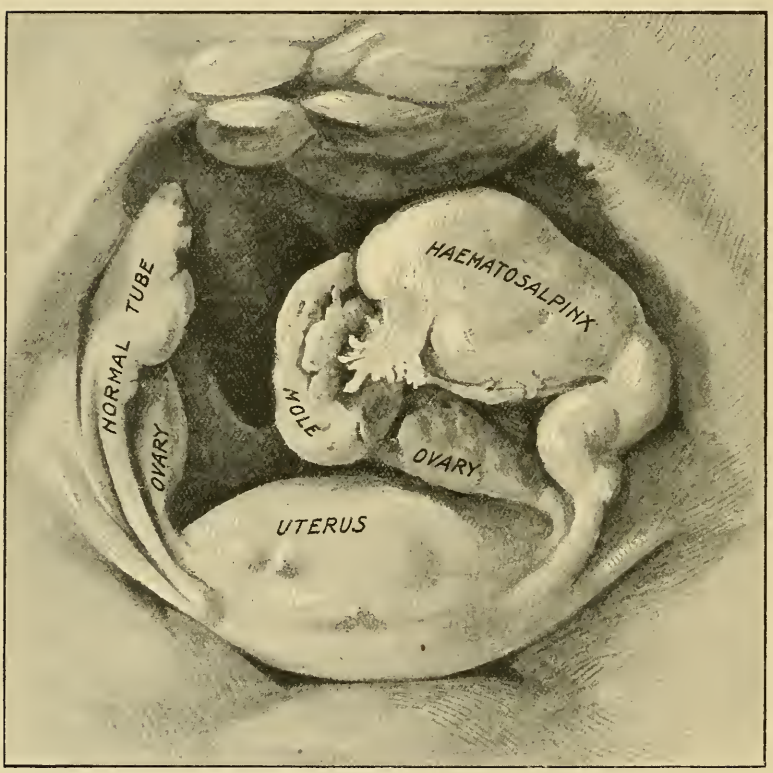


FIG. 82.—Tubal Abortion with Hæmatosalpinx (Bumm). The ovum, converted into a mole, has been expelled from the tube, which remains distended with blood. The gravid tube occupies the left posterior quarter of the pelvis, and is connected by a pedicle with the uterine cornu.

82) ; it may in rare cases be found in the utero-vesical pouch. Pulsating vessels are often to be felt beneath it. Its physical characters do not distinguish it from tubal enlargements due to other causes, and its nature can only be deduced from the accompanying symptoms.

It appears certain, from clinical observation, that symp-

toms other than those just described do not occur until hæmorrhage has taken place—either into the tube itself, into the peritoneal cavity, or into the broad ligament. In the majority of cases the first sign of disturbance is the occurrence of a little external bleeding from the uterus (metrorrhagia), which may precede by a few days any of the more serious symptoms which inevitably follow. These symptoms, which will be described below, are commonly regarded as the symptoms of extra-uterine gestation, but they are in reality *secondary* symptoms, inasmuch as they result not directly from the gestation, but from certain disturbances which either destroy the ovum or greatly modify the course of its development. Naturally the secondary symptoms are not uniform, for they depend upon the nature and extent of the damage which has been sustained by the ovum and the tube. In any case a marked and rapid transformation of the clinical features takes place as soon as the normal course of gestation is disturbed.

(*b*) **After the Occurrence of Internal Bleeding.**—The uterine hæmorrhage continues and is usually steady, not irregular, moderate in amount, and dark in colour. Separation and discharge of the decidua may also occur, sometimes in the form of a complete cast of the uterus, more often in fragments ; in some cases the discharge of the decidua is not recognised at all, and it is possible that it may be cast off gradually in the form of *débris*. The characters of the decidua are definite and uniform, and their recognition may be of considerable help in diagnosis.

The decidual membrane is smooth upon its inner and rough upon its outer surface, which is also often beset with small papillary elevations. Microscopically it is seen to consist of a superficial compact layer and a deep reticulated or cavernous layer (Fig. 83). The surface epithelium is almost entirely lost, and very few glands are to be found in the compact layer, which consists of closely packed masses of oval, round, or polygonal cells with large globular nuclei—the *decidual cells*. Many large venous sinuses and numerous interstitial hæmorrhages, sometimes of large size, are commonly found in this part of the membrane after it has been shed. The deep layer contains many irregularly dilated glands, in most of which the epithelium is fairly well pre-

served. The presence of decidual cells in small numbers in tissue passed from the uterus is not of much importance, but a membrane possessing the characters above described is distinctive of pregnancy. In cases of uterine pregnancy (abortion) traces of chorionic epithelium will usually be

FIG. 83.—Decidual Cast from a case of Extra-Uterine Gestation. A large interstitial hæmorrhage is seen in the centre of membrane; to the left are seen clusters of decidual cells.

found attached to the decidual membrane, but naturally this will not be found in extra-uterine pregnancy.

The clinical results of internal bleeding in tubal pregnancy are variable and mainly depend upon two factors, viz., the *amount* and the *rapidity* of the bleeding. If the hæmorrhage is rapid and the amount of blood lost great, the effused blood becomes distributed over the general peritoneal cavity, and tends to accumulate in the most dependent parts,

viz., the pouch of Douglas and the renal pouches ; this is the *diffuse* type sometimes spoken of as 'intra-peritoneal flooding.' If the hæmorrhage is slow or the amount small, the effused blood becomes quickly shut off from the general peritoneal cavity by the formation of lymph around it ; this is the *encysted* type.

Diffuse Type of Intra-peritoneal Bleeding.—Occasionally a single sudden hæmorrhage occurs so rapid and profuse as to cause death in a few hours, before surgical aid can be obtained. Blacker has recorded a case which ended fatally in twenty minutes. In such a case the hæmorrhage is always intra-peritoneal, and may be due either to tubal rupture or to tubal abortion. More frequently diffuse hæmorrhage is less severe, ceases spontaneously after a time, and, while imperilling the patient's life, is not necessarily fatal. It may, however, recur after an interval and prove ultimately fatal. The initial attack of bleeding may occur without any exciting cause, when the patient is at rest in bed, or even when asleep ; more often it appears to have been induced by some slight muscular effort, such as that entailed by ordinary domestic work or by the act of defæcation.

Severe abdominal pain, sudden in onset, situated in one or both iliac regions, is usually the first symptom. It is often quickly followed by vomiting, and may lead to faintness or, less often, to actual loss of consciousness from syncope. Upon these symptoms supervene, in cases of profuse bleeding, the signs and symptoms of concealed hæmorrhage—pallor, rapid and feeble pulse, deep laboured breathing (air-hunger), restlessness, coldness of the extremities or of the whole skin-surface of the body, sweating, depression of temperature. Slight hæmorrhage from the uterus will also usually occur.

The presence of a large amount of free blood in the peritoneal cavity can usually be detected by percussion ; when the patient is lying down, it gravitates into the flanks, which accordingly become dull, and the area of dulness shifts slowly when the position of the patient has been altered.

Gradual improvement supervenes, and in two or three days the symptoms generally subside. There is, however, great risk under these circumstances of renewal of the bleeding, which will manifest itself by recurrence of more or

less acute attacks of pain and of some of the symptoms of shock. Even while the patient is confined to bed recurrences of bleeding may be met with, a risk which is sufficiently explained by the anatomical points already referred to.

When a diffuse hæmorrhage, though severe, is not large enough immediately to imperil life the symptoms resemble those of the condition often called 'peritonism,' and are common, with variations, to many circumstances under which fluid suddenly escapes into the peritoneal cavity. These symptoms are acute abdominal pain, at first located to one iliac region, but soon becoming general, with more or less profound shock; the symptoms of shock differ from those of profuse bleeding chiefly in the absence of restlessness and air-hunger. The pain may last for many hours, and may be accompanied by abdominal distension and by vomiting, but the latter is not persistent.

The *diagnosis* of tubal pregnancy under these conditions is sometimes fairly simple. When there has been a profuse loss of blood the fact that internal bleeding has occurred will be obvious from the signs already described; a history of a recent short period of amenorrhœa giving place to slight uterine bleeding, will suggest the possibility of ectopic pregnancy. Pelvic examination may show softening of the cervix and a swelling behind or to one side of the uterus which represents the gravid tube (Fig. 82). These findings together make up a strong presumptive case for the diagnosis of tubal pregnancy with internal bleeding.

When the loss of blood has been less severe than this the symptoms are less characteristic, and there may be some doubt whether hæmorrhage, perforation of a hollow viscus, or acute inflammation, *e.g.*, of the appendix, has occurred. The history may be misleading, inasmuch as early uterine pregnancy may be associated with any of these surgical disasters in women in the fertile period of life. And further, the local conditions may be misleading, for cases have occurred not infrequently in which a pelvic swelling taken for a gravid tube has been revealed by operation as an acutely inflamed ovary or a small ovarian cyst. If the condition of the patient is not too serious to allow of delay, the further course of the case will often clear up the diagnosis, for after internal hæmorrhage has ceased the general con-

dition rapidly improves, while with such lesions as perforative peritonitis the general condition as rapidly deteriorates.

Encysted Type of Intra-peritoneal Bleeding.—In this form bleeding is more gradual than in the diffuse type, and the signs of internal hæmorrhage are usually inconspicuous. Nevertheless a certain amount of pallor and quickening of the pulse are present from the first, and may become more pronounced as the case proceeds. The two prominent symptoms constantly encountered are *pain* and *uterine hæmorrhage*.

The pain which is met with is almost always sudden in onset, and usually spontaneous, although muscular effort may appear to excite it ; it is always severe, and may be intense ; beginning in one or other iliac region, it soon affects the whole abdomen, but later on may again become localised ; it is frequently attended with vomiting and other signs of shock, sometimes with faintness or actual syncope ; after lasting acutely for several hours it subsides, and thereafter may recur at varying intervals of a few days or a week, until several attacks have been sustained ; sometimes continuous pain without exacerbations follows the first attack.

The uterine hæmorrhage often begins before the first attack of pain ; it shows the characters already mentioned, and may be accompanied by discharge of a decidual cast, either complete or in fragments.

After a few days an irregular elevation of the temperature occurs, as a rule, and this symptom in association with pain often leads to the erroneous diagnosis of an inflammatory lesion. This rise of temperature is due in part to the peritonitic reaction which occurs around the effused blood, and results in its isolation, and in part to the absorption of fibrin ferment or other products from the dead blood.

The blood which is slowly poured into the peritoneal cavity from the gravid tube tends to accumulate in the most dependent part of the peritoneal cavity—the pouch of Douglas. In some cases, probably when the bleeding is very slow, the effused blood does not reach the pouch of Douglas at all ; it becomes rapidly encysted by adhesive peritonitis and is detained in contact with the bleeding part, which may be the abdominal ostium, or a rent in some other part of the tube. An encysted collection of blood in the pelvic peri-

toneal cavity is called a *pelvic hæmatocele ;* when formed around the abdominal ostium it is distinguished as *peritubal,* when formed upon a rupture in the proximal part of the tube it is called *paratubal* (Handley). Around these encysted collections of blood a *false capsule* is rapidly formed by the deposition of layers of lymph externally, and beneath this by organisation of the superficial layers of the blood-clot. In this way a membrane one-eighth to one-quarter of an inch in thickness may be formed. In those rare instances where intra-ligamentary rupture occurs, the blood is slowly poured out between the layers of the broad ligament, and this condition is distinguished as a *pelvic hæmatoma.* Hæmatocele of the pouch of Douglas is far commoner than either of the other varieties.

In some instances considerable *intra-tubal* hæmorrhage may occur without any escape of blood from the tube taking place. An acute attack of pain, or it may be recurrent attacks, indistinguishable from those just described, usually accompanies this form of hæmorrhage also.

Diagnosis of the Encysted Type.—From the symptoms which have been already described, a presumptive diagnosis of tubal pregnancy with internal bleeding can generally be made. The physical signs met with are mainly those of a pelvic effusion, the nature of the effusion being inferred from the history and the symptoms.

A large pelvic *hæmatocele* forms a swelling extending upwards above the pubes (Fig. 84). The hypogastric region is prominent, and pressure causes considerable pain. On palpation a dome-shaped swelling, ill-defined in outline and elastic in consistence, can be made out. Its position is usually, but not always, mesial. On percussion the note is subresonant. The surface of the swelling felt in the hypogastrium corresponds to the roof of the hæmatocele, which is formed by omentum and coils of intestine adherent to one another and to the mass of effused blood beneath them.

On vaginal examination, it will be found the whole uterus including the cervix is displaced forwards and pressed close up to the back of the symphysis pubis ; sometimes it is somewhat elevated, and may be displaced a little to one or other side of the middle line. Softening of the lips of the os externum may be recognisable. The rest of the pelvis is

occupied by the effusion which has crowded the uterus out of its normal position ; sometimes it depresses the floor of the pouch of Douglas and causes bulging of the posterior fornix. The consistence of the swelling is generally elastic ; it may be almost doughy in parts, or on the other hand areas which

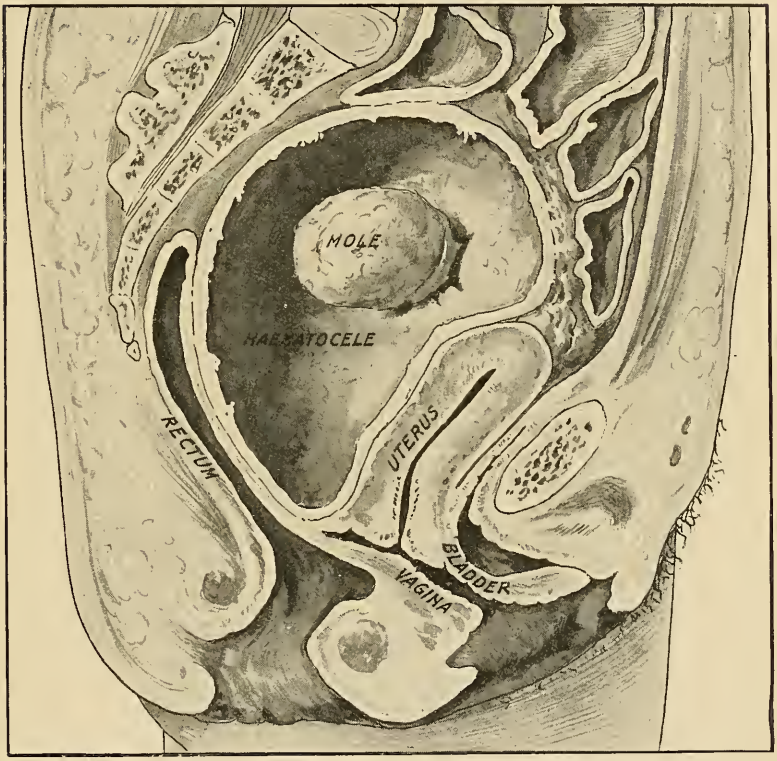


FIG. 84.—Pelvic Hæmatocele shown in Mesial Sagittal Section (Bumm). The section shows the Hæmatocele distending the Pouch of Douglas and pushing the Uterus forwards. Attached to the left wall of the Hæmatocele is a Tubal Mole.

feel firm and solid may be encountered. These variations are probably due to incomplete or irregular coagulation of blood. The pelvic mass is continuous with that felt above the pubes. On rectal examination it may be found to fill the sacral hollow (Fig. 84) and compress the bowel ; thickening of the utero-sacral folds is also commonly felt, and probably results from coagulation taking place upon their surfaces.

Differential Diagnosis of Pelvic Hæmatocele.—In considering this point it must be recollected that although the great majority of pelvic hæmatoceles are due to ectopic pregnancy, this is not invariably the case. Thus Jayle has recently collected seventeen cases due to rupture of a small blood cyst in the ovary, and others have been recorded from rupture of a tubo-ovarian varicocele.

A pelvic hæmatocele must be carefully distinguished from *retroversion* of the *gravid uterus ;* the differential diagnosis is not always easy. It is, however, of practical importance, for if the treatment of a retroverted gravid uterus were applied to a case of pelvic hæmatocele, disaster might follow from rupture of the hæmatocele.

The history usually presents well-defined differences. Thus retention and incontinence of urine, common in retroversion when the uterus has grown large enough to fill the pelvis, are exceptional with hæmatocele. Bleeding from the uterus may occur with either, but the discharge of decidual tissue is only met with in extra-uterine cases. Attacks of severe abdominal pain strongly favour the diagnosis of hæmatocele.

On bimanual examination, the bladder being empty, it is necessary, in order to recognise that the condition is a pelvic hæmatocele, to determine that the body of the uterus lies in front of the swelling which fills the pouch of Douglas. Anæsthesia may be required to determine this point satisfactorily. If the fundus cannot be felt in front, or to one or other side, it may be concluded that the swelling felt posteriorly is the enlarged uterine body. Two points of minor importance may assist the diagnosis, viz., the gravid uterus is of more uniform consistence than the hæmatocele, and may sometimes be felt to undergo intermittent contractions.

Peri- and para- tubal hæmatoceles cannot be clinically distinguished from a hæmatosalpinx. Effusions of blood into the broad ligament (hæmatoma) closely resemble inflammatory effusions in the same position (cellulitis), and are best distinguished by the clinical history.

(*c*) **Secondary Abdominal Pregnancy.**—The clinical diagnosis of this condition presents considerable difficulties, and in the great majority of the recorded cases diagnosis has not been made until, following upon the death of the fœtus, the

gestation sac has become altered by infection or by shrinkage. The history of the pregnancy presents abnormal features, such as attacks of abdominal pain in the early months, usually accompanied by hæmorrhage ; but when the ovum survives a tubal rupture, the amount of internal bleeding appears to be inconsiderable, and the accompanying symptoms less urgent than those described above. In advanced pregnancy the local conditions may closely resemble those of normal pregnancy, the position of the body of the fœtus, and of the presenting part, showing little abnormality. Careful examination under anæsthesia would, however, show that the uterus was small, and was displaced to some extent by the gestation sac, while the use of the sound would indicate that the uterine cavity was only slightly enlarged and empty. The differential diagnosis of the intra-ligamentary from the intra-peritoneal variety presents even greater difficulties ; in the latter the fœtus usually lies above the pelvic brim and is more freely movable ; while in the former the head may lie unusually low in the pelvis to one or other side, and the mobility of the fœtus may be unusually limited. The uterus would be displaced to the side opposite to the head. But absolute reliance cannot be placed upon these points.

The fœtus often perishes before full time is reached ; it may, however, survive until term has been exceeded. A definite attack of pain such as could be called a "false labour" does not in all cases occur ; but when met with it is usually synchronous with the death of the fœtus. After this occurrence the abdominal enlargement may gradually decrease from absorption of fluid ; on the other hand it may rapidly increase in size either from hæmorrhage into the gestation sac, or from infection reaching it from the bowel. Infection is usually distinguishable from hæmorrhage by being accompanied by fever.

Old cases of secondary abdominal pregnancy in which the fœtus has been retained for prolonged periods after its death are almost incapable of being clinically diagnosed. It is curious to note the extraordinary resistance to infection from adherent intestine which this condition exemplifies. Notwithstanding the large mass of dead matter which the gestation sac contains, and its contiguity to sources of infec-

tion, the processes of dry gangrene (mummification) and subsequent incrustation with lime salts may proceed without apparent interruption, and the presence of the large foreign body thus built up may be tolerated for many years with little apparent inconvenience. Many instances are on record of a lithopædion being found in the body of a woman who died of some independent malady, at an advanced age. Thus Kuchenmeister has recorded the case of a woman who died at the age of eighty-seven, and in whose body a lithopædion was found which, it was estimated, had been retained for a period of fifty-seven years. In some cases, however, the lithopædion has proved to be the direct cause of death from intestinal obstruction.

Treatment of Extra-Uterine Pregnancy

This subject must be considered in relation to the various clinical phases just described.

(1) In the case of an *unruptured extra-uterine gestation*, the gravid tube or ovary should be removed without delay by abdominal section. The great probability that internal hæmorrhage will occur, with its serious risks to life, necessitates this preventive operation being performed in all cases. The operation required is, in the case of tubal pregnancy, the removal of the gravid tube ; the corresponding ovary is, as a rule, healthy, and should not be removed. The operation is simple, and the prognosis correspondingly favourable.

(2) In the case of *internal hæmorrhage* of the *diffuse type*, operation is again invariably necessary. The conditions may here be very unfavourable for surgical interference, as when the patient has been brought nearly to death by a profuse intra-peritoneal flooding. Nevertheless, the abdomen must be immediately opened and the bleeding vessels secured. Success may be obtained in cases apparently desperate, and the responsibility which the operator undoubtedly takes in operating is, under the circumstances, perfectly justifiable. Saline transfusion into the median basilic vein should be practised in the worst cases before or during the operation, and is of the greatest assistance to success. Rapid work is necessary when the patient is under the anæsthetic ; the pedicle should therefore be secured in

the simplest and most expeditious manner possible. As much of the effused blood as possible should be cleared away, but time must not be consumed in making a complete peritoneal toilet. One to 2 pints of warm, sterile, saline solution may be poured into the peritoneal cavity before the wound is closed and left to be absorbed.

In cases of *encysted internal hæmorrhage* there is no necessity for immediate operation, but in the majority of cases recovery does not take place without surgical interference of some character. *Palliative treatment* has been extensively resorted to in such cases ; it consists in confining the patient strictly to bed, and trusting to absorption of the dead blood taking place by natural processes. This may undoubtedly occur, but the process is very slow and many weeks, running even into months, may elapse before the effusion has disappeared. Little or nothing can be done by medical measures to hasten absorption. In some cases a hæmatocele may be observed to increase steadily in size, notwithstanding that the patient is confined to bed ; this is generally due to progressive or repeated hæmorrhage from the gestation sac. Increase in size may, however, be due to infection of the hæmatocele, and is then usually accompanied by aggravated pain and fever. It follows that when palliative treatment is decided upon, a guarded prognosis should be given, for resort may ultimately be necessary to some operative procedure.

A pelvic hæmatocele may be attacked from the abdomen, or from the vagina by posterior colpotomy. The advantage of the former is that the damaged tube is completely exposed, and can be removed ; the pelvic peritoneal cavity can be properly cleared out, and the wound closed without drainage. When the vaginal operation is adopted, the hæmatocele is simply evacuated and drained ; evacuation is necessarily incomplete, and as coagulated blood does not come away freely by drainage, several weeks may elapse before the cavity has completely closed up. The advantage is that the risks attending opening of the general peritoneal cavity are avoided, and in cases of infected hæmatocele this risk is undoubtedly a serious one. Vaginal drainage is, therefore, the operation of choice in an infected hæmatocele ; in other cases the abdominal operation is, as a rule, to be preferred as

being more thorough and followed by shorter convalescence.

(3) *Secondary abdominal pregnancy*, whether intra-ligamentary or intra-peritoneal, can be dealt with only by operative measures. The difficulty of distinguishing the two varieties has been already referred to ; it practically precludes any attempt to apply different methods of treatment to them. We shall therefore consider the method of dealing with such cases, firstly, when the *fœtus is alive and viable*, and secondly, when *the fœtus is dead*.

(*a*) It is but seldom that cases come under observation while the child is alive, and the numbers of such cases which have been operated upon is relatively small. The ideal procedure in such cases doubtless is to operate at once with the view of securing the survival of the child as well as the mother. Two great difficulties have to be encountered.

In the first place the records show that even if delivered alive, the chances of the child ultimately surviving are very small. Bland-Sutton has collated eight cases operated upon between the thirty-fourth week and term, and of these six infants died within a few hours of birth ; the other two did not survive the first year.

In the second place the presence of a quick placenta constitutes a formidable technical difficulty in operating. In opening the gestation sac it may be practicable to make the incision through a part which is closely incorporated with the abdominal parietes, when the operation may be conducted extra-peritoneally throughout. With this object, the incision may be made in the linea semilunaris instead of the linea alba. After extracting the child and dividing the cord, the membranes should be peeled off the wall of the sac and the limits of the placenta thus defined. Three possible courses are available for dealing with the placenta : firstly, to peel it off and control hæmorrhage by ligature, forceps and packing ; secondly, to leave it untouched, to keep the gestation sac open by stitching its edges to the lower part of the wound, and then to allow the placenta to separate spontaneously ; thirdly, to leave the placenta untouched, close the wound completely and trust to its absorption by natural processes. The first course leads to very profuse bleeding which is difficult to control ; although it has been occasionally

successful, in many cases the operator has been obliged to abandon the attempt, and instead to control the bleeding by plugging, and leave the placenta in its place. If the immediate difficulty of controlling the hæmorrhage can be surmounted, the results are good. If the second course is adopted, an attempt may be made a week after the operation to remove the placenta through the opening, detaching it with forceps and fingers. Thrombosis in the sub-placental vessels will probably prevent any serious hæmorrhage. Complete removal of the placenta in this way is however, impracticable, and infection of the remainder almost invariably occurs, and adds greatly to the risks of the situation. If this method is adopted, a counter-opening should, if possible, be made through the posterior fornix into the deepest part of the gestation sac, in order to provide more efficient drainage. Experience of these alternative methods is not at present sufficiently large to permit of one being definitely preferred to the others. The third course has been suggested but not tried ; it is theoretically sound if complete asepsis in operating can be guaranteed. The least failure in this respect might, however, lead to disastrous results.

The difficulties of dealing with the quick placenta have induced many operators to postpone operative interference until the death of the child has occurred in the natural course of events, no attempt being made to save it.

(*b*) After the death of the child, the only maternal risk to be considered is that of infection of the sac. The usual practice has been to delay operation for several weeks in order to allow time for thrombosis of the placental sinuses to occur and thus facilitate separation of the placenta. This is the safest course to pursue so long as no suspicion of infection has arisen. Such cases should all be dealt with, if possible, by an extra-peritoneal incision ; the placenta can then be peeled off, oozing controlled by ligature or packing, and drainage established by both the suprapubic and vaginal routes.

Disorders associated with Pregnancy

Acute Infectious Fevers.—Pregnancy forms a serious complication of the acute exanthemata, not because the

severity of the disease is thereby increased, but on account of the high percentage of cases in which abortion or premature labour occurs. This risk is common to all, but appears to be greatest in the cases of small-pox, scarlet fever, and typhoid. Abortion is probably brought about in nearly all cases by transmission of the disease, *i.e.*, by hæmatogenous infection of the ovum. The effect of high temperature in causing abortion is doubtful, and it appears that the severity of the disease is the most important factor. It has now been shown that nearly all the exanthemata may be thus transmitted to the fœtus. In the case of enteric fever it has been shown that the bacillus may be demonstrated in the fœtal organs, that Widal's reaction may be obtained from the blood, and that ulceration of Peyer's patches may also be found in the fœtal intestine.

Inasmuch as pregnancy does not influence the course of the disease, obstetric interference is not as a rule indicated. In cases of typhoid or scarlet fever of exceptional severity, induction of abortion would probably be a useful prophylactic measure, if undertaken early in the course of the disease, for if abortion should occur in the critical third or fourth weeks the maternal prognosis would be considerably prejudiced.

Chronic Infections (Tubercle, Syphilis, and Gonorrhœa). —*Phthisis* in women does not unfavourably affect fertility, nor does it unfavourably influence the course of pregnancy ; usually the resulting children are well developed and show no sign of tuberculous disease when born. During pregnancy phthisical women often appear to improve in health, but in the puerperium the tuberculous disease usually advances more rapidly. In a certain number of cases of acute miliary tuberculosis or advanced pulmonary phthisis, the transmission of tubercle bacilli from the mother to the fœtus has been demonstrated, but this occurrence is rare. Only in quite exceptional circumstances does phthisis form an indication for the artificial termination of pregnancy.

Syphilis is the most frequent of all the constitutional causes of premature interruption of pregnancy. In the great majority of instances the source of infection of the ovum is *paternal ;* whatever may be the stage of the disease in the father, it is possible for the fœtus to be infected. The

influence of *maternal* syphilis upon the ovum and upon the course of pregnancy varies according to the incidence of the disease. Women infected with syphilis just before or at the time of conception miscarry in about three out of every four cases, the fœtus showing definite signs of the disease. In the cases of women infected subsequent to conception but early in pregnancy abortion often ensues, but with relatively less frequency. If the infection occurs late in pregnancy, the course of pregnancy may be uninfluenced and the fœtus born alive and apparently healthy. Cases probably occur in which a woman, impregnated by a man who, though syphilitic, displays no local infective lesion, contracts syphilis from the fœtus *in utero*. This is known as *conceptional* syphilis, and is characterised by complete absence of all lesions characteristic of the primary stage. Sometimes a syphilitic fœtus is born without any outward sign of the disease being recognisable in the mother, and even if she suckles her child she does not become obviously infected. This is known as *Colles's law of immunity*, but it is doubtful whether the mother under these circumstances is not in reality affected by syphilis in an attenuated form ; the fact that she does not become obviously infected from suckling her child appears to support this view.

Until recent years great controversy raged about the question of the transference of syphilitic infection from the fœtus to the mother. The question has, of course, been greatly simplified by the discovery of the biological test for syphilis known as the Wassermann reaction. The absolute reliability of the negative reaction has not yet been established, and many difficulties beset it. But observations appear to show that in circumstances such as those exemplifying Colles's law, a positive Wassermann reaction can rarely be obtained from the mother except when she is actually pregnant. Yet her child may show definite signs of the disease ; and women who have once been infected with ' conceptional ' syphilis may continue to give birth to syphilitic infants even when married to men who are free from the disease, showing that the disease is present in some form which is capable of transmission. The accuracy of Colles's observations is therefore supported by the results of the test.

As syphilis is a bacterial disease, these observations imply

that the specific organism is transmitted with the spermatozoa, and that the ovum is either infected at the moment of fertilisation, or that the infection attacks it very soon afterwards. The frequency with which abortion occurs may be explained partly by diseased conditions arising in the fœtus or its membranes, or in the decidua, and partly by the general maternal infection exerting a toxic effect upon the growing ovum. The latter is rendered probable by the fact that morbid conditions are not always found in the ovum or decidua in these cases. In all syphilitic women, however, there is a very high percentage of abortion ; fertility is not lessened, and of a series of pregnancies some may terminate in miscarriage, others in the birth of syphilitic infants, while one or other of the series may yield an infant showing no signs of the disease at birth. According to statistics published by Hochsinger, not more than from 9 to 10 per cent. of the children borne by syphilitic mothers are free from signs of the disease at birth, and of this small number a certain proportion develop signs of syphilis, such as a positive Wassermann reaction, during the first six months of life.

Anti-syphilitic treatment of *both* parents is, of course, required in all cases where there is evidence of the existence of the disease in either, and even in cases of paternal syphilis, when the mother is apparently unaffected, full treatment with salvarsan or mercurial injection should be advised. A syphilitic infant should never be suckled by a wet nurse, nor should a syphilitic mother ever be allowed to suckle her child, for the specific organisms may possibly be transmitted through the milk.

Gonorrhœa.—When this disease is contracted during pregnancy it is apt to give rise to a very *acute* form of vulvo-vaginitis, associated with extensive redness and œdema of the skin surfaces, and the formation of diphtheritic patches upon the mucous membranes. The acute form almost necessarily ends in abortion and is accompanied by the gravest risks of upward spread of the infection to the uterus, the Fallopian tubes and the pelvic peritoneum. Acute decidual endometritis, gonorrhœal peritonitis, or an acute abscess of the tubes will then result, all these conditions being of the most serious nature.

Chronic gonorrhœal infection is most commonly met with in the form of endocervicitis or vulvo-vaginitis accompanied by a purulent discharge. The former condition is usually associated with sterility, but it is not an absolute bar to conception. Vulvo-vaginitis, on the other hand, has little influence either upon conception or on the course of pregnancy. In many instances impregnation and infection occurred at the same time, but so long as the disease is not acute, abortion is uncommon, and it is probably quite exceptional for the uterus to be invaded by the organisms. After abortion or labour, however, in all cases there is the risk that the disease may spread to the Fallopian tubes, ovaries, and pelvic peritoneum with the most serious or even fatal consequences. During labour, gonorrhœal vaginitis, whether acute or chronic, entails serious risks of infection of the eyes or mouth of the fœtus. Gonorrhœal discharges at all stages of pregnancy accordingly require careful local treatment by vaginal douching and other measures, the details of which are described in text-books of gynæcology. It must also be remembered that gonorrhœal discharges are infectious at all stages, and even when the specific organism has disappeared other pathogenic bacteria may be present ; the greatest care must, therefore, be taken to prevent the transmission of infection to other patients.

Malaria.—This disease is not often seen in this country in connection with pregnancy. In countries where malaria is endemic it is however of frequent occurrence, and experience shows that the disease exerts little, if any, unfavourable influence upon pregnancy. Attacks of malaria are apt to be more frequent and severe than usual when pregnancy has occurred, and recrudescence of the disease is not infrequent in cases in which it has become quiescent. It is said that the infant of a malarial mother often suffers from malarial attacks in infancy, but it does not appear that the characteristic plasmodium has been detected in the fœtal blood. Malaria may be treated freely with quinine, for the oxytocic properties of the drug are said to be very feeble in the subjects of this disease, a result which may probably be referred to tolerance established by previous administration of large doses.

Diseases of the Heart and Circulatory System.—Chronic

valvular disease of the heart is not infrequently met with in pregnant women. In a series of cases collated by Fellner, in about 70 per cent. the mitral valve was the one affected, mitral insufficiency, either alone or combined with stenosis, being much commoner than simple stenosis, which is but rarely met with in pregnancy. Lesions of both the aortic and the mitral valves may also be met with, but simple aortic lesions are rare in women.

Of valvular lesions the most serious of all to the pregnant woman is mitral stenosis ; many observers have estimated the mortality of this lesion at about 50 per cent. Mitral incompetence and aortic lesions of both kinds are not nearly so serious as this ; only when compensation has broken down are these lesions of serious prognosis. Owing to the high mortality of mitral stenosis, many authorities have suggested that women suffering from this affection should be advised not to incur the risk of pregnancy. In other forms of valvular disease it is certainly unnecessary for this advice to be given, save in cases where failure of compensation has previously occurred, either in connection with pregnancy or from some other cause. In such cases the gravity of the risk attending pregnancy is increased to an untold extent.

As long as compensation is maintained a woman suffering from mitral lesions may pass successfully through a number of pregnancies without running any serious risk. Irregular hæmorrhage during the early months is not uncommon, and there is a marked tendency to the occurrence of abortion or premature labour. But such women are in constant danger of a cardiac breakdown from which the most serious consequences may ensue. It may be precipitated by a concurrent illness, such as a fresh attack of rheumatism or some pulmonary complication ; often it appears to be solely the result of the pregnancy. Compensation is most likely to break down in the later months of pregnancy, or during labour, or in the course of the puerperium. The first few hours after labour are perhaps the most serious, on account of the sudden fall in blood pressure which follows the evacuation of the uterus.

The greatest care must therefore be taken to maintain compensation during pregnancy and avoid over-strain ; so long as this is successful, pregnancy will continue favourably.

There is no doubt however that every pregnancy inflicts

further damage upon a diseased heart and reduces its reserve of force ; it therefore shortens the patient's expectation of life considerably, even if all should go well. Signs of failing compensation, such as anasarca, scanty and albuminous urine, bronchitis, pulmonary œdema, or marked irregularity of the pulse, should be treated by absolute rest in bed, simple diuretic and aperient drugs, and cardiac tonics, such as digitalis or strophanthus, in small doses. If serious symptoms, such as dyspnœa and cyanosis, or pulmonary œdema supervene, venesection, to the extent of 8 to 10 ounces of blood, will afford immediate relief. The most serious result of the breakdown is the accumulation of fluid in the chest, hydrothorax and hydropericardium, as these add a mechanical obstacle to the action of the already over-loaded heart. These conditions must be relieved by tapping.

Generally speaking treatment should be first directed to restoring the heart's action rather than to interfering with the course of pregnancy. If the breakdown has occurred in the first half of pregnancy, abortion should be induced as soon as the condition has improved, for it is certain that the heart will not stand the severe strain of the later months. The process of abortion is easy, and the patient will be rescued from a grave danger. When the breakdown occurs in the second half of pregnancy, the same general treatment should be followed, but this often fails, and then to terminate pregnancy gives the patient her only chance of recovery, for if compensation breaks down seriously towards the end of pregnancy her prospect of surviving the strain of labour is very poor.

If pregnancy should occur in a woman who has previously suffered a failure of compensation, whether in pregnancy or not, abortion should be at once induced. In the later months of pregnancy the success of interference is more doubtful, for the reasons just stated. Operative measures for the rapid evacuation of the uterus are probably less risky than the induction of abortion or labour by the slow methods, for labour pains involve a serious strain on the heart ; when the child is viable there is no reason to delay an operation which is inevitable. The course which offers the best chance is therefore to deliver by Cæsarean section,

and thus avoid the pains of labour altogether. If this is done a general anæsthetic should not be administered, the operation being done under spinal anæsthesia or local cutaneous anæsthesia.

Varices in the lower extremities and labia majora are apt to become greatly aggravated by pregnancy, giving rise to pain and inability to walk. Vulval varices sometimes rupture from traumatism, leading to profuse hæmorrhage, which has been known to prove fatal in the absence of proper surgical aid.

Renal Diseases.—The influence of chronic nephritis upon pregnancy has already been referred to when considering the subject of albuminuria. To distinguish between this condition and the transient renal changes characteristic of the ' pregnancy kidney ' may be somewhat difficult when the existence of chronic nephritis has been unsuspected before conception. In the following points chronic nephritis with pregnancy will be found to differ from the albuminuria of pregnancy :

(1) Albuminuria and œdema appear much earlier (see p. 114).

(2) Œdema is likely to affect the face and upper extremities.

(3) Characteristic changes may be found in the arteries, the heart, and the retina (exudative retinitis may, however, occur in the albuminuria of pregnancy).

(4) Intercurrent attacks of acute nephritis may occur.

(5) Epithelial casts and renal cells may be found in the urine.

In general terms it may be said that, on the one hand, the effect of pregnancy usually is to aggravate the renal disease ; on the other, the disease usually causes the pregnancy to terminate prematurely, tends to destroy the fœtus by inducing placental degeneration, and may cause the death of the mother from uræmia. Convulsions which ensue under these circumstances must be regarded as mainly uræmic in origin. The fœtal mortality in chronic nephritis is very high indeed.

From these considerations it will be apparent that pregnancy in the subjects of chronic nephritis involves grave risks. A patient who has survived an attack of uræmia in a

previous pregnancy should not be allowed to incur the risks again ; and if conception does take place, abortion should be induced without delay. In the case of a prim gravida, or if previous pregnancy has not been attended with serious complications, palliative treatment may be adopted ; but the chances of the patient bearing a living child are by no means good. The occurrence of an intercurrent acute attack of nephritis almost always ends in abortion.

It will be obvious that pregnancy with chronic nephritis calls for the most careful observation of the patient's condition. Regular weekly examination of the urine should be made, including a quantitative estimation of urea. Restriction of proteid elements in the diet is desirable from the beginning, and this of itself will result in a comparatively low output of urea. Regular and frequent estimation is accordingly the only way in which a diminution due to toxæmia can be recognised. Irregularities of diet, fatigue, and chill are especially to be avoided, and it must be recollected that the premonitory symptoms of eclampsia (see p. 528) include such inconsiderable symptoms as headache, functional disturbances of vision, and complaints of ' indigestion.' During the later months of pregnancy the condition of the fœtus should be watched ; if the fœtus dies it is desirable to induce labour without delay, for the risks attending the condition are not greatly diminished until the uterus has been evacuated.

Bacillus Coli Infection of the Urinary Tract: Pyelitis of Pregnancy.—It is only within the last twenty years that the occurrence of an acute form of pyelitis, or pyelonephritis, during pregnancy has been recognised. It was observed that the condition could be cured by inducing abortion, and it was assumed in consequence that pregnancy was the immediate cause, as the earlier name ' Pyelitis of Pregnancy ' implies. It has however been established that in practically all cases the disease results from bacillus coli infection, usually as a pure infection, but sometimes mixed, pyogenic organisms being also present. Further, although the renal pelvis is the position in which the most marked lesions occur, the kidney substance, the ureter, and, though more rarely, the bladder, also may be infected. It is accordingly better to name the condition ' Bacillus Coli Infection of the Urinary Tract.'

The condition seldom occurs earlier in pregnancy than the fourth month; occasionally an acute attack of great severity occurs in the puerperium, when care will be required to distinguish it from acute septicæmia (p. 581). It may assume either an acute or a chronic form, and as a rule there have been no symptoms of cystitis or of renal disease previous to the pregnancy.

In the *acute* form the patient is suddenly seized with acute abdominal pain, sometimes attended with shivering, and leading after a few hours to abdominal distension and sometimes to vomiting. The pain, diffused at first, usually settles down to the right side, but in a small proportion of cases the left is the affected side. The bowels are usually constipated and the tongue furred. The kidney, when palpable, is tender and may be felt to be enlarged; often there is well-marked rigidity of the rectus muscle over it, and so much tenderness that detailed palpation is impracticable. Sometimes the pain on pressure is felt chiefly in the costo-vertebral angle. The gravid uterus usually shows no abnormality, but tenderness, with thickening of the terminal portion of the ureter (usually the right), may be detected *per vaginam* on deep palpation at the sides of the cervix anteriorly. The temperature may be raised to 103° to 104° F., and the fever continues irregularly for some days unless controlled by treatment. Sometimes rigors occur and the general condition of the patient is so much affected as to give rise to anxiety.

On examination of a catheter specimen of the urine it will usually be found distinctly acid, less often it has been observed to be neutral or alkaline. It is turbid and contains flocculent *débris*. In the great majority of cases culture methods yield a pure bacillus coli; sometimes pyogenic organisms are also present. There are no renal casts, but the deposit may contain a little blood, and there is always a good deal of pus, shed epithelial cells, and epithelial *débris* from the urinary passages. The quantity of urine is usually small, and there is no offensive odour. A trace of albumen can usually be found. In many cases the onset is less acute than this, but fever and severe pain in the abdomen or flank are invariably met with.

In the *chronic* form the symptoms are, of course, less

characteristic. There is often slight irregular fever, but this is not invariable, and the patient complains of backache and sometimes of persistent irritability of the bladder. On palpation the kidney is sensitive and may be enlarged.

The right kidney shows a marked predisposition to this disease, but not to the extent that was at one time believed. Out of 129 cases collated by Albeck and Lenharz, in 67 the right kidney alone was affected, in 26 the left kidney alone, and in 36 both right and left were affected. It has been shown further by autopsy, and by direct observation upon cases submitted to operation, that the ureter may become dilated, at any rate in its abdominal part, upon the affected side. It is generally agreed that this dilatation does not affect the pelvic portion of the ureter, *i.e.*, that it is only found in the part which lies above the pelvic brim. It will be recollected that ureteral dilatation similar to this has been observed in autopsies on cases of eclampsia.

Acute catarrhal inflammation is found in the renal pelvis and ureter ; sometimes, but this is very rare, there is also cystitis. From obstruction to the ureter a pyonephrosis may supervene.

Causation.—This disease is in all cases due to infection of the urinary tract by the bacillus coli. When other organisms are also found in the urine secondary infection has probably occurred. The manner in which the bacillus coli obtains access is at present unsettled. There are three possible routes to be considered. The first and most obvious is an ascending infection *per urethram ;* as Williamson has pointed out, this may occur either by direct infection of stagnant urine above the ureteral block, or by the peri-ureteral lymphatics. By this route the bladder would first be involved, but clinically the special symptoms of cystitis are seldom observed in the early stages. The second is by the circulation, the organisms passing through the kidney and attacking the mucous membrane of the renal pelvis. The third is a direct infection from the bowel, the organisms passing from the colon through the peri-ureteral cellular tissue to gain access to the ureter, or possibly to the kidney. Even if the route by which the infection travels were known, we do not know what causes the bacillus coli to assume pathogenic activity during pregnancy.

A mechanical explanation has been suggested, viz., that pressure exerted by the gravid uterus upon the ureter at the pelvic brim may predispose to the occurrence of infection by leading to retention of urine above the line of pressure. The infection may, however, occur in the early months before the uterus is large enough to compress the ureter; and further, other conditions such as uterine tumours likely to produce mechanical obstruction of the ureter do not lead to urinary infection.

Diagnosis.—An acute attack of pyelitis, with its sudden febrile onset and its preponderance on the right side, must be carefully distinguished from acute appendicitis, which it resembles in many respects. Acute cholecystitis may also give rise to a similar clinical picture. Ultimately the diagnosis depends upon the condition of the urine, and the importance of carefully examining a catheter specimen in cases of doubt must be borne in mind. The urine is acid, more or less turbid, and contains a microscopic amount of pus; culture is required to demonstrate the organisms.

Treatment.—In an acute case the patient should be kept in bed, the diet restricted to fluids, chiefly milk, and large doses of an alkaline diuretic, such as citrate or acetate of potash administered with the object of increasing the amount and reducing the acidity of the urine. It appears that an acid urine forms a better culture medium for the bacillus coli than an alkaline urine. The acute symptoms usually subside in a few days if a free flow of urine can be maintained, and it is probable that much of the initial severity of the attack results from dilatation of the renal pelvis and ureter. The bowels must be freely moved every day. The urinary infection can be directly attacked in two other ways, viz., by urinary antiseptics and by autogenous vaccines. The most powerful urinary antiseptic is the substance known as urotropin, a synthetic compound prepared from formaldehyde (formalin). This body is efficient only in an acid medium, and it is desirable to administer with it a salt which tends to increase the acidity of the urine, such as acid sodium phosphate. Ten grains of urotropin with twenty grains of acid sodium phosphate may be given three times a day. It is clear that this line of treatment cannot be combined with the administration of alkaline diuretics, and it has been

found best to withhold urinary antiseptics until the acute symptoms have subsided. The results obtained with vaccines are unreliable, and this treatment is rarely required. Medicinal measures usually suffice to relieve the symptoms, but the specific organism often persists in the urine after the symptoms have all disappeared.

If medical treatment fails to relieve the condition, two other methods of treatment are available, viz., *induction of labour* and *nephrotomy*. The results of inducing labour have been almost invariably favourable, and this clinical fact lends support to the theory of mechanical obstruction of the ureter already referred to. Nephrotomy should be reserved for cases in which all other measures have failed, or in which the urgency of the symptoms suggests the possibility of pyonephrosis, or of infection of the renal cortex.

Catheterisation of the ureter, either alone or with irrigation of the renal pelvis, is sometimes practised.

Diseases of the Liver.—Pregnancy is, in some unexplained manner, one of the predisposing causes of *acute yellow atrophy* of the liver. This rare disease induces changes in the organ similar to those often found in fatal cases of puerperal eclampsia. Jaundice in pregnant women is always a somewhat serious symptom, owing to the fact that it may indicate the onset of acute yellow atrophy. No treatment is known which will arrest the course of this malady.

Diabetes is seldom found in association with pregnancy, probably because it exerts an influence unfavourable to conception. The frequent occurrence of traces of lactose in the urine of healthy pregnant and nursing women must be recollected, and due care exercised before arriving at a diagnosis of diabetes. The prognosis is mainly influenced by the severity of the disease; in moderate cases pregnancy and labour may end favourably both to mother and child; in severe cases there appears to be a special risk of diabetic coma in the later months or during labour. Hydramnios is said to be frequently associated with diabetes, the amniotic fluid containing sugar.

Diseases of the Nervous System.—*Neuritis*, supposed to be of toxæmic origin, sometimes occurs during pregnancy; it may affect a single nerve or may be multiple. Severe

pain, limited to the distribution of the affected nerve, is the prominent symptom. It disappears rapidly after labour.

Chorea is not infrequently met with during pregnancy ; it is commoner in the first than in a subsequent pregnancy. In about two-thirds of the cases there is a previous history of rheumatism, or of chorea and rheumatism combined. By many obstetric writers it is regarded as a toxæmic disease, but no definite post-mortem evidence of the changes characteristic of death from pregnancy toxæmia has so far been discovered, although a considerable number of cases that have terminated fatally have been recorded. There is therefore not the same sound reason for including it in the toxæmic diseases as there is in the case of eclampsia and pernicious vomiting. It is better to regard it as a disease of the nervous system, the occurrence, or the recrudescence, of which is favoured in some way by pregnancy.

The majority of cases of chorea are of a mild type ; spontaneous abortion occurs in from 10 to 15 per cent., but very few cases terminate fatally. At the same time it must be recognised that cases of great severity sometimes occur which end in death in spite of energetic treatment, including the induction of abortion. Lepage has recently collected 77 fatal cases, and in nearly half of these abortion failed to arrest the course of the disease. Owing to the variability in type the mortality rate is difficult to determine and is placed variously at from 5 to 40 per cent. by different writers. Andrews and Hall have reported 40 cases at the London Hospital with 5 deaths, equal to 12·5 per cent. ; in the fatal cases abortion occurred in two spontaneously, and in two others it was induced. Fletcher Shaw has recorded a series of 32 consecutive cases in Manchester without a death.

In cases of exceptional severity where a fatal termination may be feared, the choreic movements become so intense as to prevent the taking of nourishment and to hinder sleep ; there may also be delirium, rise of temperature and of pulse rate, the appearance of a morbilliform eruption and retention of urine. The causation of the latter symptom, which Lepage regards as peculiarly grave, is unknown.

The *treatment* of this disease in mild cases is satisfactory, and as a rule pregnancy ends favourably both to the mother

and the child. Absolute rest in bed and careful feeding are very important. Sedatives such as bromide and chloral should be used sparingly, and chiefly for the purpose of ensuring sleep when this is rendered necessary. The bowels should be kept open freely, and the functions of the skin and kidneys kept active by the 'eliminative' methods described in connection with the treatment of pernicious vomiting.

In cases which belong to the 'severe' class, and in which the symptoms of danger just mentioned appear, pregnancy should be terminated by a method which necessitates the minimum of operative interference, and is suitable to the period to which pregnancy has advanced (see p. 653). The undoubted influence of pregnancy in the causation of the disease is a sufficient justification for this procedure, but it will be recollected that a favourable result for this operation cannot be with certainty anticipated.

Herpes gestationis.—This rare affection is believed to be a neuritis of toxæmic origin. It is characterised by multiform skin lesions, the commonest type being crops of papules, vesicles, or pustules of herpetiform character; they are distributed chiefly upon the buttocks, the flanks, the forearms, and the back of the thighs. Sometimes the disease affects the skin of the whole body, is very intractable, and may cause serious exhaustion from uncontrollable irritation and want of sleep.

Appendicitis.—This disease is comparatively rarely seen in connection with pregnancy. There is no clinical evidence that pregnant women display any special liability either to an initial attack or to recurrences. The seriousness of the complication when it does occur is, however, unquestionable, especially in the later months of pregnancy. When pus is present there is great risk of the uterine contents becoming infected, even when the abscess has been treated by drainage; miscarriage occurs in 90 per cent. of such cases (Abrahams), and the bacillus coli has been found in the fœtal blood. Following the uterine infection there are risks of septicæmia, or of suppurative disease of the uterine appendages, in the puerperium. These special risks may be regarded as an indication for prompt surgical interference when appendicitis occurs during pregnancy, and the indication is even more emphatic when the illness is a recurrence and not an initial

attack. Induction of abortion or of premature labour is not advisable as an alternative to an operation ; it is reasonable to suppose that the rapid reduction in size of the uterus might be the means of disturbing protective or limiting adhesions, thus facilitating generalisation of infection over the peritoneal cavity. But before the evacuation and drainage of an appendicular abscess infection of the uterine contents may have already occurred ; the risks are therefore not entirely eliminated by the operation. As a rule an infected ovum is quickly expelled without interference, but the advisability of inducing abortion by one of the methods described on p. 653, after the abscess has been evacuated, must be carefully considered. The interests of the mother are predominant, for the chances of the survival of the child, when viable, are very slight.

Ovarian Tumours.—The presence of a unilateral ovarian cyst, if uncomplicated, forms no hindrance to conception ; bilateral solid tumours, whether benign or malignant, are rarely found in association with pregnancy. Single cysts of moderate size, which rise into the abdominal cavity along with the uterus as it develops, give rise to no symptoms and are often not discovered until labour sets in ; or even until, during the puerperium, the size of the abdomen draws attention to their presence. Small tumours which during pregnancy remain in the pouch of Douglas are subjected to considerable pressure, and may give rise to pain and interference with the functions of the bladder and rectum. They may obstruct labour (see p. 433), and they not infrequently give rise to serious trouble during the puerperium, from axial rotation of the pedicle or from injury received in labour. As a rule, ovarian tumours discovered during pregnancy should be at once removed ; ovariotomy in pregnant women is no more serious than in the non-pregnant. There is, however, considerable risk of abortion following the operation. During the first two months of pregnancy the risk of abortion is high (16—17 per cent.), it then decreases and remains comparatively low until the seventh month, when it again rises and is estimated by some observers as high as 20 per cent. to 25 per cent. It follows that the time for performing ovariotomy should be carefully chosen, in uncomplicated cases, with a view to diminishing the risks to the child.

Tumours of the Gravid Uterus.—I. Fibroids and Pregnancy.—Conception does not readily occur in a uterus which is the seat of a fibroid tumour when that tumour is submucous or interstitial in position, whether it is small or large. Subperitoneal fibroids, however, are probably no hindrance to conception, whatever their size may be. And although the first-named varieties are a hindrance to conception they

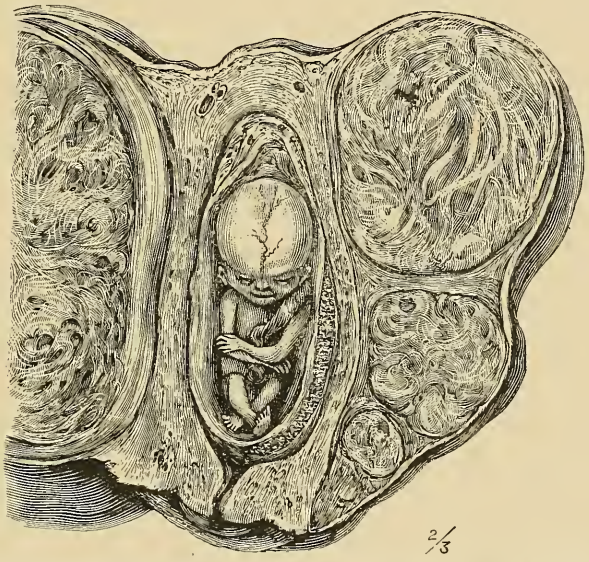


Fig. 85.—Pregnancy with Multiple Fibroid Tumours of the Uterus. The Placental Insertion lies partly in the Lower Uterine Segment. (Bland-Sutton.)

by no means absolutely prevent it, so that the association of fibroids with pregnancy is not uncommonly met with.

The Diagnosis of Pregnancy in a uterus enlarged and distorted by the presence of one or more fibroid tumours may present great difficulties. The degree of difficulty will depend in the main upon the position of the uterine cavity and its relation to the tumour or tumours. Sometimes the cavity is anterior and accessible to abdominal palpation, when diagnosis will be comparatively easy; but it may lie behind the tumour which intervenes between it and the abdominal wall; or, as in Fig. 85, it may be placed between two tumours, when diagnosis will be very difficult. Until

the presence of the fœtus can be directly detected by palpation, or by auscultation of the heart, the diagnosis of pregnancy can only be presumptive. During the first five months the greatest importance must be attached to amenorrhœa ; sudden cessation of the menses in a patient with a fibroid tumour almost invariably implies pregnancy, unless the age of the menopause has been reached. But sometimes irregular hæmorrhage takes the place of amenorrhœa, and this change is not so significant, as it frequently occurs in connection with fibroids from other causes. Signs of activity in the breasts carry, perhaps, less than their usual importance in these cases, because secretion is sometimes found in the breasts of nulliparous, non-pregnant women who are the subjects of uterine fibroids. Pregnancy causes rapid enlargement with softening of the uterus and, to a less extent, of the tumours which it contains. Owing to the distortion caused by the new growths, the alterations in shape characteristic of the early months of pregnancy cannot be made out, while softening of the cervix is usually late in appearing. A uterine souffle can often be heard over some part of a non-gravid fibroid uterus, so that the presence of this sign also is unimportant. It will thus be readily seen that diagnosis must be difficult at this stage of pregnancy ; repeated examinations will be required, and even then it may be necessary to postpone diagnosis until the period at which the fœtal heart can be heard.

During the later months the gravid part of the uterus may be found to occupy almost any position with regard to the tumour ; usually it is placed more or less laterally, but may be in the upper or lower portions of the mass. Upon its position will depend the degree of ease with which the fœtal heart or limbs can be detected.

Clinical Course.—Pregnancy certainly causes recognisable softening of fibroid tumours, but opinions differ as to whether it causes their rate of growth to increase, and the truth is not easy to establish. Upon the general course of pregnancy and the development of the fœtus, fibroids exert no unfavourable influence, unless some complication should arise. A fibroid tumour impacted in the pelvis may cause severe pressure symptoms as the uterus develops, but these effects are due to the accident of its position. Axial rotation of a stalked sub-

peritoneal fibroid may occur, though very rarely, during pregnancy ; and previously existing adhesions may become troublesome through being stretched. But in the majority of cases the course of pregnancy is attended by very little more discomfort than may be met with when there are no fibroids present. There is, however, undoubtedly a somewhat greater risk of pregnancy ending prematurely either in abortion or premature labour. The effect of fibroids upon labour will be considered in a later section (p. 435).

Management.—Pregnancy should be allowed to continue until term, unless (1) severe complications due to the tumour arise, or (2) the tumour is so situated as inevitably to cause insuperable obstruction during labour. In the former case the offending tumour should, if possible, be removed by myomectomy and the uterus allowed to remain. Even with improved technique this operation is attended with a considerable risk of abortion, for Devine has recently collected 130 cases with an abortion rate of 23 per cent. In the latter case there are three possible alternatives : (*a*) abortion may be at once induced ; (*b*) the pregnancy may be allowed to continue until term, and the child then delivered by Cæsarean section, the uterus being at the same time removed ; (*c*) after extracting the child the tumour may be enucleated and the uterus preserved (Cæsarean myomectomy). The induction of abortion cannot be recommended ; the position of the fibroid tumour necessarily renders dilatation of the cervix difficult, and if interference is necessary to evacuate the uterus, serious mechanical obstacles may have to be overcome. Cæsarean hysterectomy (see p. 735) at or near term is no more serious than hysterectomy at an earlier period when the fœtus is non-viable, and is therefore on the whole the best method of dealing with such cases. Cæsarean myomectomy although theoretically preferable is actually a more difficult and dangerous operation than hysterectomy, and has seldom been performed.

II. **Malignant Uterine Disease and Pregnancy.**—Pregnancy is unknown in connection with carcinoma of the body of the uterus ; it may, however, be found in association with sarcoma, and there is reason to believe that in some cases of chorionepithelioma (deciduoma malignum) this growth has commenced during pregnancy. Cancer of the cervix and

pregnancy are not infrequently associated (Fig. 88), and the diagnosis does not present the same difficulties as in the case of uterine fibroids and pregnancy ; for, the body of the uterus being unaffected by the disease, the characteristic changes in it can be recognised at any period of pregnancy. Amenorrhœa may be obscured by irregular hæmorrhage from the growth, and of course the condition of the cervix prohibits the characteristic softening of pregnancy from taking place.

Management.—When the cervical carcinoma is in the *operable* stage the presence of pregnancy should be ignored, and the whole uterus removed with the disease. The method of operating will depend upon the size of the uterus—*i.e.*, the stage of pregnancy ; if the child is viable it can be first delivered by Cæsarean section ; if non-viable the uterus can be removed by abdominal hysterectomy, the method of Wertheim being the most suitable. When the disease is *inoperable* abortion may be induced in the early months ; but in advanced pregnancy it is probably better to wait, and then deliver the child by Cæsarean section at term.

Abortion : Miscarriage

Abortion is the expulsion of the ovum from the uterus at a period before the fœtus has become viable ; the term *viable* signifying that the fœtus is capable of maintaining its existence when born. Until the middle of the seventh calendar month (twenty-eighth week) the fœtus is non-viable, therefore pregnancy terminating before this date is said to terminate by abortion. The term *miscarriage* is best employed as a synonym of abortion ; sometimes, however, the latter is used only during the first two to two and a-half months, when the ovum possesses no properly developed placenta, while the former is applied to all stages of the non-viable period later than this. Such a distinction is confusing and has nothing to commend it, because the process is scarcely affected by the presence or absence of the placenta. Abortion is a miniature labour consisting of a stage of dilatation, a stage of expulsion, and a stage of retraction. It may occur spontaneously or be intentionally induced ; the former alone will be considered here, the latter being dealt with among the Obstetric Operations.

Causation.—The causes of abortion are very numerous ; they will be best considered in three groups : (1) *pathological conditions* of the mother and of the ovum (including the fœtus) ; (2) *traumatic causes ;* (3) *general or systemic causes.*

(1) The *pathological conditions*, maternal and fœtal, which may cause abortion have been already tabulated (see p. 107), and the more important ones fully considered as disorders of, or associated with, pregnancy, and need not be again set out. Of these conditions, some are very apt to cause abortion, others rarely cause it ; and from what has been said of each, no difficulty will be experienced in distinguishing between those which are important in this respect and those which are not. A certain number of cases may be due to low implantation of the ovum in the uterus (*Placenta prævia*). After the ovum has been expelled it is impossible to demonstrate the position which it occupied, but occasional opportunities arise of investigating such ova *in situ*, when the conditions are seen to be very favourable to the occurrence of abortion.

(2) Of the traumatic causes the most important is *injury to the uterus or the uterine contents.* This may occur in a variety of ways, as from direct violence, such as blows or kicks on the abdomen, or from severe falls or other accidents. Sometimes the uterus is actually ruptured by a blow on the abdomen; both blows and falls, however, usually operate, not by injuring the uterus, but by causing detachment of some part of the ovum from the uterine wall. Abortion may be brought about by passing the sound or some other instrument into the uterine cavity, either inadvertently, or with the intention of setting up a miscarriage. Sometimes, however, the passing of the sound into the uterus does not produce this effect. Unless some definite injury is caused to the ovum, such as rupture of the chorionic sac, or partial detachment, no harm follows ; there is no doubt that the sound may be passed into the decidual cavity without injuring the ovum at all. If infection is carried into the uterus by dirty instruments abortion may be brought about by septic endometritis. Operations upon the gravid uterus or the uterine appendages are frequently, though by no means invariably, followed by abortion, which in this case probably results from disturbance of the uterine or pelvic circulation. Injury to the ovum does not necessarily produce abortion immediately, an interval of

several days, or even a week or two, elapsing before abortion sets in.

Next in importance to direct or indirect injury must be placed a group of conditions which cause abortion by *exciting the uterine centre* situated in the lumbar enlargement of the spinal cord (see p. 278), the stimulus being conveyed through the central nervous system. Extreme degrees of grief or fright, as from sudden bereavement or personal danger, may cause abortion, especially in women of nervous temperament; and it is clear that such conditions can only operate in the manner just indicated. Over-fatigue, especially from dancing and riding, probably acts in the same way. Operations upon distant parts performed during pregnancy also sometimes induce abortion, which must clearly be produced through the central nervous system. These conditions, all of which involve 'shock' to important nerve-centres, may be justly classed as traumatic.

Many drugs have from time to time been employed for the illicit production of abortion (abortifacients), but no scientific study of their mode of action has ever been made. The greater number of them are irritant poisons.

(3) The *general or systemic causes* consist of a number of conditions, the action of which in causing abortion is imperfectly understood. Thus consanguinity of the parents, high altitude, and hot climate are all believed to cause it. Unhealthy occupations pursued by the mother alone or by both parents, such as working with lead, mercury, or glass, undoubtedly also cause abortion. Habitual over-indulgence in alcohol, and excessive sexual intercourse, are said to favour its occurrence.

Of all the systemic causes of abortion, however, the most important in all respects is *syphilis*. In all probability more abortions are due to this disease than to any other cause. In cases of repeated abortion the probability of a paternal syphilitic taint is very high, and the Wassermann test must be applied to both parents. The manner in which constitutional syphilis produces abortion is not known; in many cases, clinically syphilitic, no morbid changes can be found in chorion or decidua after its discharge. Investigations are now being undertaken to determine whether the specific organism can always be detected in such cases; its presence

in large numbers would indicate fœtal bacterial toxæmia as the cause of the abortion. Men who have suffered from the disease, but in whom syphilitic lesions are no longer clinically recognisable, may either beget children definitely syphilitic, or the development of the ovum may be brought to an early termination by abortion. It is therefore clear that the infective agent must be transmitted in some form to the developing ovum.

It must be added that the cause of abortion in a particular case is often very difficult to trace ; and in exceptional cases an apparently healthy patient may have a series of abortions for which no adequate explanation can be discovered. When syphilitic infection, associated disorders, and traumatic causes of abortion can be excluded, the most probable cause is an unhealthy condition of the endometrium upon which the ovum was embedded, and to this condition a series of abortions may be due.

Frequency.—It will be clear from this enumeration of the conditions which cause it that abortion is not an uncommon event. From some recent statistics presented by Professor Malins to the Obstetrical Society of London it appears that in this country about 16 per cent. of pregnancies terminate by abortion—*i.e.*, one abortion occurs to every five births of viable children ; and further it appears that abortion is nearly twice as frequent among the classes from which hospital patients are drawn as among the well-to-do. Presented in another way, it may be said that from 30 per cent. to 40 per cent. of all fertile women pass through one or more abortions during the period of child-bearing. Far more abortions occur in the third month of pregnancy than in any other month. Women who are the subjects of syphilis or Bright's disease often sustain a succession of abortions without carrying any pregnancy to term.

Clinical Features.—The symptoms which accompany the process of abortion are *hæmorrhage and pain*. Hæmorrhage is almost invariably the initial symptom, and is caused by separation of the ovum or of some part of the decidua from the uterine wall (Fig. 86). The bleeding is usually slight at first, but as the abortion proceeds it may become profuse, and dangerous, or even fatal in its severity. Clots form in the vagina, and more rarely in the uterus itself, when

bleeding is free. A young ovum of six to ten weeks with its membranes may be discharged either entire or piecemeal along with these clots and thus be overlooked. Pain is usually intermittent, and is due to uterine contractions. Sometimes it is continuous, and the uterus when examined may be hard and unchanging in consistence; at other times the whole process may be attended with little or no pain. After the discharge of the ovum from the uterus the pain ceases.

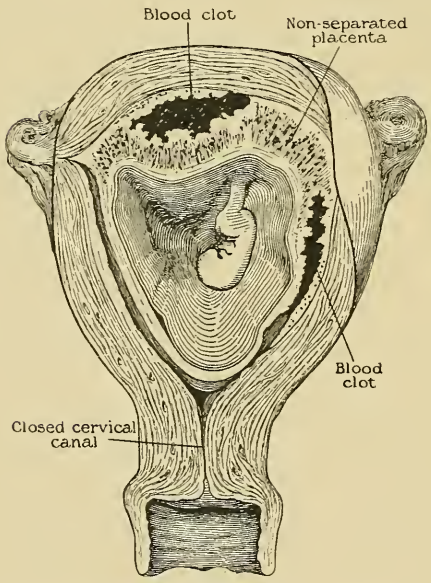


FIG. 86.—Abortion: Stage I. Ovum partially detached, Cervix closed. (Edgar.)

On vaginal examination *dilatation of the internal os* can usually be recognised soon after the onset of these symptoms. The student must recollect that in a multipara the external os is often patulous under ordinary conditions, allowing of the introduction of the finger-tip into the cervical canal; but the internal os is never opened early in pregnancy except by active contractions. In the dilating cervical canal the finger will often feel a soft, somewhat bulging swelling, which may be a clot of blood, or the lower pole of the ovum detached from the uterine wall and lying free in the lower part of the uterine cavity and cervix (Fig. 87). Sometimes dilatation of the cervix proceeds irregularly, the external os opening last after the internal os has been already fully dilated; this offers some difficulties in diagnosis, for the condition of the cervix within the external os cannot well be recognised.

When the cervical canal is sufficiently dilated, the ovum is expelled through it by the uterine contractions, either entire or in pieces; an early ovum discharged in pieces may

escape notice unless all the blood and blood-clot passed by the patient is carefully examined. The uterus rapidly retracts and the cervix closes down, so that in a few hours no trace of dilatation can be detected, and the consistence of the uterine body is firm. For several days a hæmorrhagic discharge occurs, similar to the lochial discharge of the puerperium, and the uterus itself undergoes a process of involution similar to puerperal involution. If a portion of the ovum or decidua remains unexpelled from the uterus, the hæmorrhage will continue until it has been got rid of and involution will be arrested.

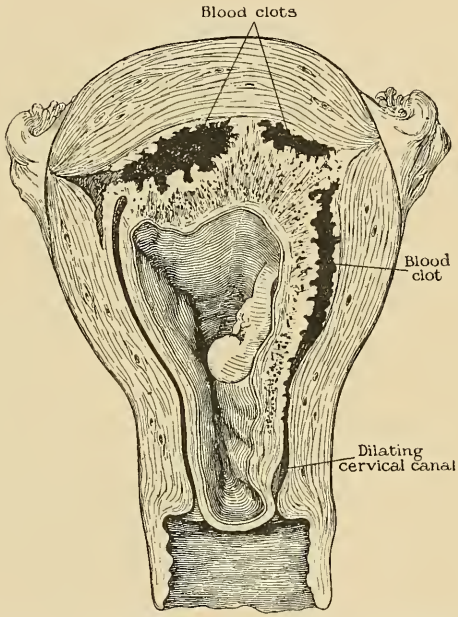


FIG. 87.—Abortion: Stage II. Ovum almost completely detached, Cervix dilated, Lower Pole of Ovum protruding. (Edgar.)

A number of terms are in common use in this country which are intended to describe certain clinical varieties or phases of the process of abortion; thus we speak of *threatened* abortion, *inevitable* abortion, *incomplete* abortion, and *missed* abortion.

Threatened Abortion.—Sometimes pain and hæmorrhage occur during early pregnancy, without leading to dilatation of the cervix. Caution must be exercised in attributing these symptoms in all cases to threatened abortion, for they may result from a number of other causes—*e.g.*, the bleeding may not come from the body of the uterus at all, but from some concurrent disease of the cervix, such as a polypus or a malignant growth. And when the bleeding can be clearly traced to the uterine cavity, abortion by no means always

ensues : it is certain that a good deal of hæmorrhage may occur in early pregnancy without causing detachment of the

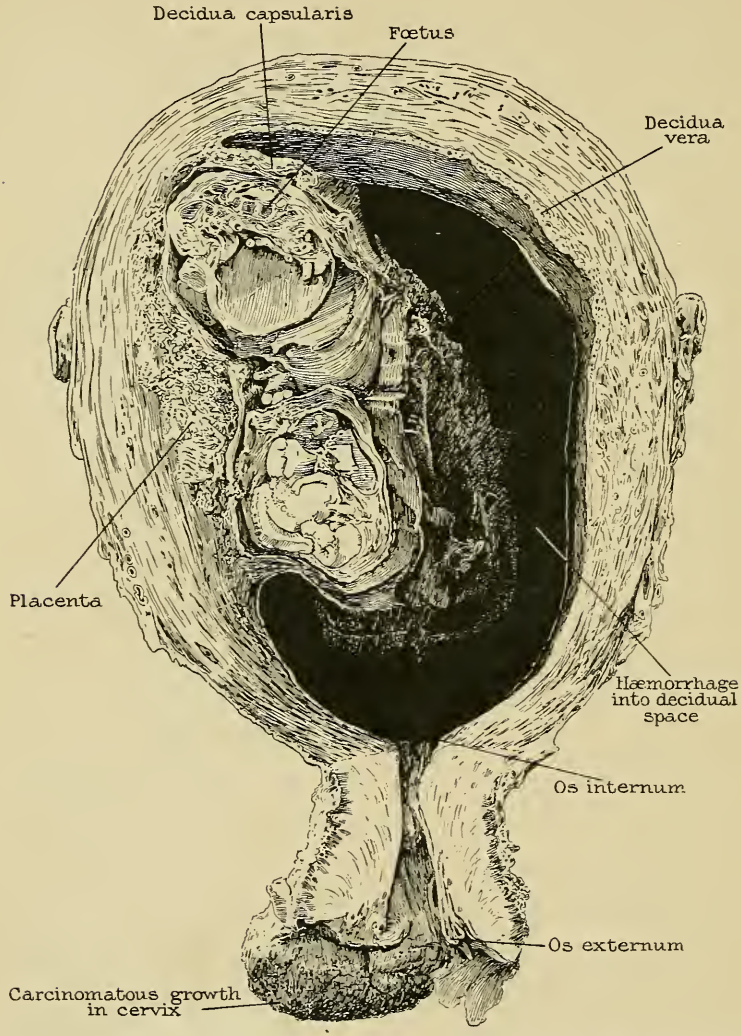


Fig. 88.—Gravid Uterus (Fourth Month), showing extensive Decidual Hæmorrhage without Detachment of the Ovum. (Charing Cross Hospital Museum.)

The uterus was removed for carcinoma of the cervix.

ovum. For example, hæmorrhage may occur from the undetached decidua in decidual endometritis, or in con-

nection with cardiac or hepatic disease of the mother. It is even possible that slight detachment of some part of the ovum or the decidua itself may be repaired and the gestation allowed to continue. In Fig. 88 it is seen that considerable hæmorrhage has occurred into the decidual space without separation of the ovum, which is intact, though somewhat compressed. Clinically, the bleeding in this case was attributed to the coincident malignant disease of the cervix. Whatever may be the explanation, it is certain from clinical experience that one or more smart hæmorrhages in early pregnancy, or slight bleeding continued for several weeks, is not incompatible with the completion of gestation and the birth of a healthy child. Pain and hæmorrhage must therefore never be regarded as certain indications of abortion unless they are accompanied by dilatation of the internal os, or the expulsion of some part of the ovum (fœtal or maternal); when unaccompanied by these changes it is convenient to refer to the condition as *threatened abortion*. By suitable treatment the process can often be arrested here and the danger averted. It is not uncommon, however, for symptoms of threatened abortion to subside, and after an interval to recur with greater severity. The condition must, however, always be regarded seriously, for alarming and even fatal hæmorrhage may occur from separation of an early ovum without any attempt being made by the uterus to evacuate its contents spontaneously. Such cases, being unattended by dilatation of the cervix, are technically cases of threatened abortion.

Inevitable Abortion.—When the pains are regular and intermittent, when the internal os commences to open, when the ovum has been detached and can be felt in the cervix, or when some portion of the decidua has been expelled, the process of abortion cannot be arrested, and is therefore said to be *inevitable*. It is not in all cases easy to say whether or not an abortion is inevitable, unless the finger can be passed up to the internal os, or unless some parts of the ovum has been discharged and recognised. Sometimes, however, it is possible to recognise uterine contractions by palpation, and this forms a useful sign, for in threatened abortion the uterus does not contract sufficiently to be recognisable by palpation. During a contraction, the uterus becomes uniformly hard in

consistence, and often a little irregular in shape ; the contraction may be very prolonged, lasting for several minutes. In the early stages this sign is sometimes useful in diagnosis, but eventually dilatation of the cervix is the change upon which the recognition of an inevitable abortion depends. The distinction between threatened and inevitable

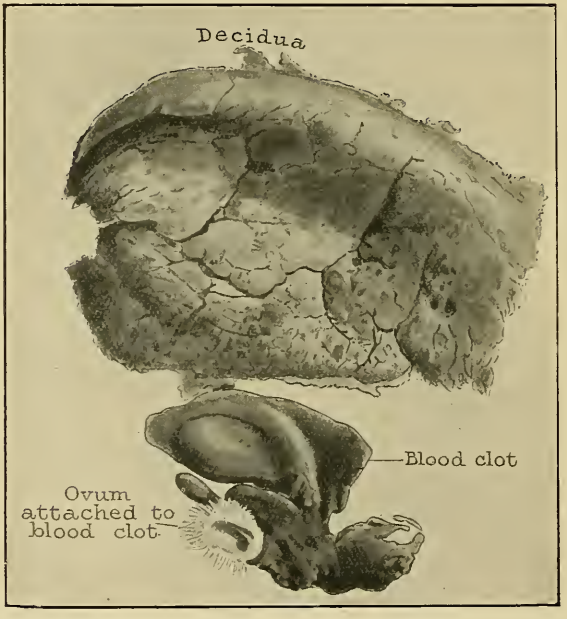


FIG. 89.—Two to Three Weeks' Abortion. The Chorionic Sac is partially covered with Villi, and has become attached to a piece of Blood Clot.

abortion is an important practical point, for the two phases must be differently treated.

Incomplete Abortion.—This name implies that some portion of the placenta or of the decidua has been retained in the uterus ; the condition is also often termed ' retention of products of conception.' Continuance of bleeding, with absence of the expected involution of the uterus, are the chief symptoms ; to these may be added those of septic infection, if the cavity of the uterus has not been kept sterile.

Missed Abortion.—This term has already been explained when describing the fleshy or carneous mole (p. 148).

Symptoms of threatened abortion occur, which subside, and after a variable period a mole is expelled.

Anatomy of Abortion.—The condition of the ovum when

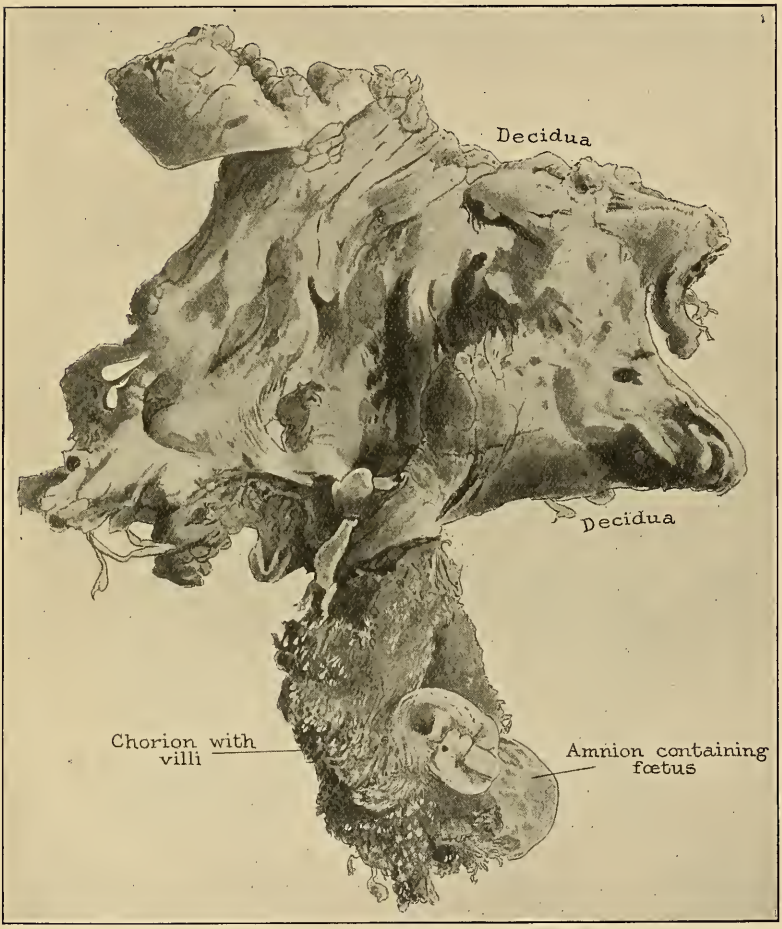


Fig. 90.—Six Weeks' Abortion. The Ovum has escaped from the Decidua Capsularis, the Chorion has ruptured, the Amnion is entire. (Charing Cross Hospital Museum.)

expelled depends partly upon its period of gestation, and partly upon the changes which it has previously undergone. The great majority of aborted ova show no recognisable morbid change; they were apparently healthy up to the

time of their expulsion. Others show various stages of the blood-mole previously described, or of the hydatidiform mole, these, of course, being ova of the first three months of gestation. Older ova which possess a definite placenta, when retained for some weeks after the death of the fœtus, show well-defined post-mortem changes, including those already described as placental infarcts. In some cases infection has occurred previous to the abortion, and the tissues of the ovum may then be expelled in a state of decomposition and having an offensive odour.

Ova apparently healthy may be expelled entire—with or without the maternal coverings—or piecemeal. During the first and second months the ovum, when thrown off, may carry with it all the decidual coverings, the whole contents of the uterus being thus evacuated *en bloc*. More frequently the decidua capsularis is ruptured, and the ovum (chorion, amnion, and fœtus) escapes and is expelled entire through the cervix (Figs. 89 and 90). The attachments of the chorion to the decidua are so delicate at this period that the force of the uterine contractions alone severs them completely. After the second month the chorion as well as the decidua is usually ruptured (Fig. 91); the amnion, being more elastic, usually resists, but it also may be ruptured, and then the fœtus escapes and may be lost in the discharged blood. Often the chorion and decidua are so firmly attached to one another and to the uterus that a portion of chorion remains, making the abortion incomplete; this is more apt to occur with the placental chorion than with the chorion læve.

The period of gestation to which the ovum belongs may be estimated from the size and characters of the fœtus, or from the size of the chorionic sac when entire. The size and characters of the fœtus at different periods of development have been stated on p. 57; they form the best guide to the period of development of the ovum. When the fœtus has been lost other criteria must be relied upon. The size of the unruptured chorionic sac is the next best guide; during the first three months it is as follows:

4th week . . .	about 1 × ¾ of an inch	(2·5 × 2 cm.).
8th ,, . . .	,, 2 × 1¾ inches	(5 × 4 cm.).
12th ,, . . .	,, 4½ × 4½ ,,	(11½ × 11½ cm.).

Up to the eighth or ninth week the whole chorion is

covered with villi (Fig. 91) ; then those of the chorion læve atrophy, and by the end of the third month the discoidal placenta has been definitely outlined. It seldom happens that a fœtus of the size of three months' development escapes recognition in a miscarriage.

Differential Diagnosis.—Two other conditions resemble

Fig. 91.—Two and a Half Months' Abortion. (Charing Cross Hospital Museum.)

abortion inasmuch as they are characterised by the expulsion of a body from the uterus with hæmorrhage and pain : they are (1) *tubal gestation* and (2) an *intra-uterine polypus.*

(1) The former has already been referred to (p. 193). It has been pointed out that the structure of the decidual membrane is identical in both uterine and extra-uterine pregnancy, and therefore uterine abortion cannot be diagnosed unless structures recognisable as chorionic or fœtal

have been expelled from the uterus. (2) An intra-uterine polypus sometimes protrudes through the cervix, either with or without complete detachment. Hæmorrhage, pain, enlargement of the uterus, dilatation of the internal os, and the presence of a soft bulging swelling in the cervical canal may appear to justify a diagnosis of inevitable abortion. But further inquiry and examination will serve to distinguish the two, for with a polypus there will be a history of hæmorrhage, not amenorrhœa, and the customary signs and symptoms of pregnancy will be absent.

It must also be borne in mind that during menstruation the uterus undergoes changes similar to those found at the beginning of an abortion, *i.e.*, the uterine body is softened, and the cervix undergoes slight dilatation. In the case of women who menstruate irregularly, the occurrence of bleeding after a prolonged interval may be regarded as an abortion unless attention is paid to the points just mentioned. During a menstrual period no membrane is discharged except in the rare cases of "membranous dysmenorrhœa," and in these cases the membrane can be distinguished by microscopic examination from the decidua of pregnancy.

Treatment.—Prophylactic treatment is naturally of great importance. Many of the conditions described as *systemic* causes of abortion are capable of being cured by appropriate treatment. Syphilis is perhaps the most important of these, and the necessity of treating both parents in such cases has been already mentioned. The biological blood test introduced by Wassermann will enable a diagnosis of this condition to be made whenever it exists in either parent. Careful management of pregnancy in the early months may obviate certain of the traumatic causes ; and it is a popular belief, which is supported to some extent by clinical experience, that the menstrual epochs are times of greater danger, when unusual precautions are required. In cases of decidual endometritis and of repeated abortion for which no systemic or local cause can be found, curettage of the uterus is useful. If the least suspicion of syphilitic taint exists in such cases, specific treatment should also be fully carried out.

An important point in prophylaxis is that local examination of the uterus during the first three months should be

conducted with great care and gentleness, and should not be repeated unnecessarily. In cases of backward displacement unaccompanied by symptoms, abortion has frequently been caused by attempts to replace the uterus; replacement, it will be recollected, is unnecessary until definite symptoms supervene, and should, therefore, be avoided.

In *threatened* abortion the object of treatment is to arrest the process; in *inevitable* abortion the object is to assist it.

Threatened abortion is accordingly treated by confining the patient strictly to bed, by avoiding as far as possible all forms of exertion and excitement, and by the administration of sedatives. No local treatment should be adopted. After the first examination from which it has been recognised that the abortion is not inevitable, no further vaginal examination should be made unless the case proceeds unfavourably. The diet should be kept low and no alcohol given; the bowels not allowed to become confined. Various sedative drugs may be administered, some of which are general, others special in their action. The most generally useful drug is opium, and the treatment may be commenced with a hypodermic injection of a quarter of a grain of morphia, and the action of the drug maintained for two or three days by small repeated doses of opium pill or laudanum. Bromide of potassium and chloral hydrate are useful in patients of excitable temperament. Certain drugs are believed to exert a specific sedative effect upon the uterus; among them may be mentioned viburnum, cannabis indica, and ergot in small doses; it must, however, be admitted that the evidence of such an effect is unsatisfactory. After a threatened abortion the patient should be kept in bed for at least a week after all bleeding has ceased. If the symptoms recur the same rule must be strictly followed.

A case of threatened abortion may at any time become inevitable, requiring a prompt change of treatment. In any case where the amount of bleeding is sufficiently profuse seriously to affect the patient's condition, the treatment of inevitable abortion must be adopted, even if there is no dilatation of the cervix.

Inevitable Abortion.—In many cases this process will proceed naturally, and terminate without any interference on

the part of the medical practitioner, and with a perfectly favourable result. Under such circumstances nothing is required beyond the administration of ergot in full doses (one drachm of liquid extract, or 3 gr. of ergotine every four hours), which is useful in stimulating the uterus, preventing retention of fragments of the decidua or ovum, and ensuring proper retraction afterwards.

In conducting even the simplest case of inevitable abortion two points are of the greatest importance. *Firstly*, all blood-clot and blood-stained coverings must be carefully examined, as the uterine contents may be discharged piecemeal; the nurse must accordingly be instructed to save everything for the inspection of the medical attendant.

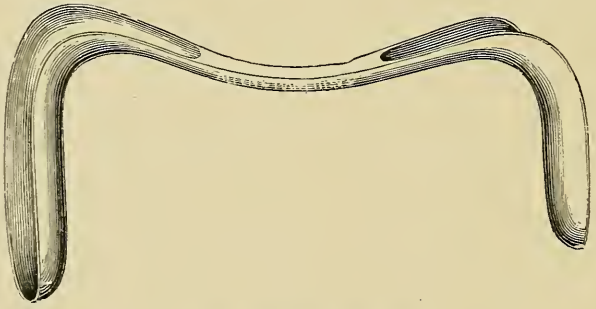


Fig. 92.—Sims' Speculum.

Secondly, the strictest antiseptic precautions must be observed throughout.

It must be understood that the management of an abortion calls for the greatest possible care in the prevention of infection, and the antiseptic routine to be described later on for the management of normal labour (see p. 308) must be applied just as thoroughly and conscientiously to a case of abortion. The results of infection may be quite as serious or even as disastrous as those of ordinary puerperal infection.

Interference during the course of an inevitable abortion may become necessary from excessive hæmorrhage, from rise of temperature, or from inability of the uterus completely to expel its contents (incomplete abortion). *Hæmorrhage* may become profuse or even dangerous at any stage of the process; it is of course due in the early stages to the separation of the ovum from the uterine wall and the consequent

rupture of maternal vessels. The hæmorrhage abates to some extent when the ovum has been completely separated, even when it is not yet expelled from the uterine cavity ; but while any portion remains undetached it will continue. *Rise of temperature* during a miscarriage necessarily arouses suspicion of infection, and is always to be regarded as an indication for terminating the process by immediate evacuation of the uterus in the manner described below. Finally, from *slow dilatation* of the cervix, from morbid adhesion of some part of the ovum, or from *weak contractions* the abortion may be so much delayed as to require interference. In abortion occurring during the first two months there is considerable risk of retention of a portion or even of the whole of the decidua. Unless the whole of this membrane is

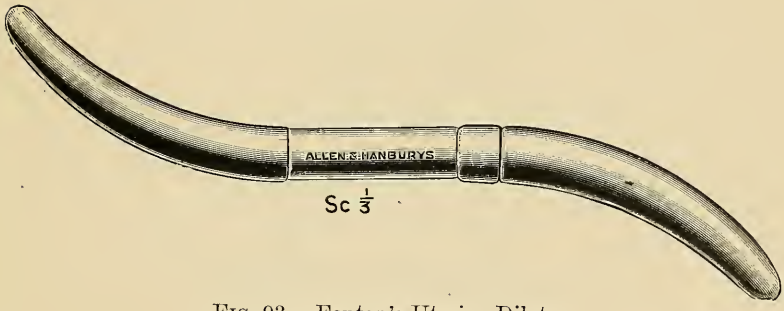


Fig. 93.—Fenton's Uterine Dilator.

found in the discharges, the case should be treated as an incomplete abortion in the manner described below. Retained decidua is a fertile source of hæmorrhage, and also predisposes to septic infection.

Whenever surgical interference is required to terminate a miscarriage the method adopted should be the same, viz., immediate evacuation of the uterus under anæsthesia. In former editions of this work vaginal and cervical plugging (tamponade) was recommended when the cervix was not sufficiently dilated to admit of the passage of the fœtus and placenta. Increasing experience of this method has shown that certain disadvantages which are inseparable from it far outweigh its advantages. These are (1) that it cannot be carried out with efficient asepsis, and while in the vagina the plug is liable to become infected ; (2) the method is slow

and uncertain, and frequently ends in incomplete evacuation of the contents, so that an operation becomes necessary after all ; on the other hand the method of immediate evacuation

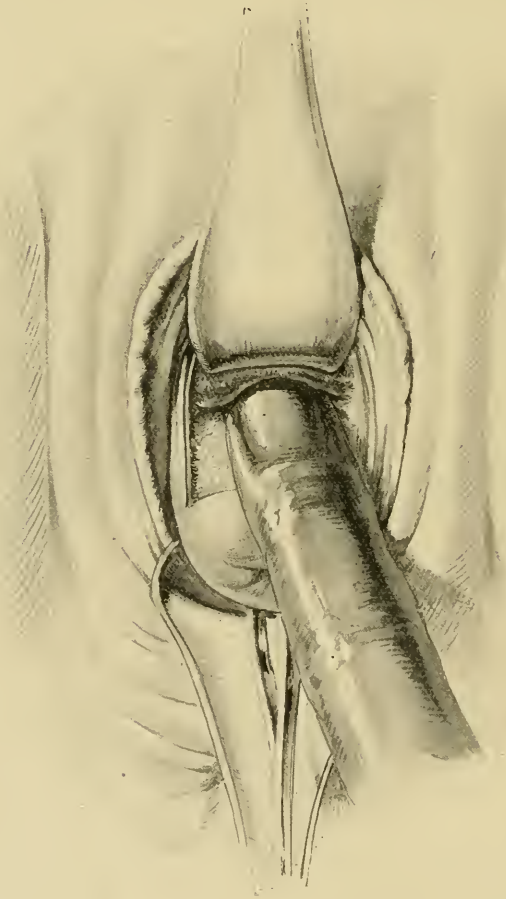


Fig. 94.—Separation of the Bladder from the front of the Cervix to the level of the Utero-vesical Pouch.

is easy, rapid and certain, and can be carried out under efficient asepsis. Vaginal plugging should therefore not be done unless operative measures are impracticable.

Immediate Evacuation of the Uterus.—Under anæsthesia the cervix is first exposed with a speculum such as that of

Sims, and then seized with volsellum forceps. The vaginal walls and cervix are next swabbed with tincture of iodine. Rapid dilatation may be performed by means of graduated metal cervical dilators (Fig. 93) until the index finger can be introduced easily into the uterus. This will allow sufficient room to remove a two and a half months' miscarriage; for cases more advanced than this incision of the cervix may be practised as in vaginal Cæsarean section (Fig. 94). The uterine body should then be gently pressed down with one hand above the pubes, until the finger in the cervix can be worked thoroughly into the cavity. The ovum must next be completely detached with the finger-tip, special attention being paid to the uterine angles. The finger should then be removed from the uterus, and by compressing the uterine body between the external hand and two fingers in the

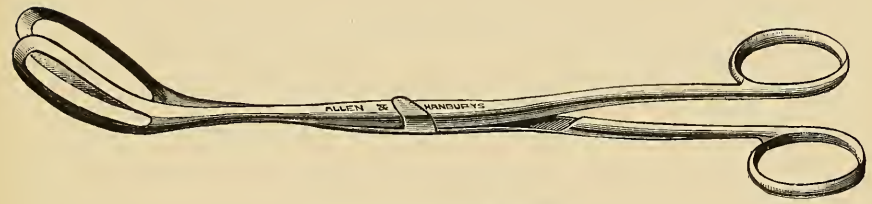


Fig. 95.—Ovum Forceps.

vagina, the whole contents may be squeezed out. If this should not succeed, a pair of blunt ovum forceps (Fig. 95) may be passed into the uterus and the ovum removed gently.

It is difficult to detach the decidual membrane with the finger, and a sharp flushing curette should be next employed to detach and remove it. The curette must be used with gentleness, and the whole uterine wall scraped from above downwards ; large pieces of thick membrane will thus be removed. The finger should then be passed again to make sure that the uterus has been completely emptied. Next the empty uterus is massaged firmly between two or three fingers passed into the vagina and the other hand placed above the pubes, and to do this properly the organ should be first anteverted. This squeezes out blood and promotes uterine retraction, thus arresting hæmorrhage.

Finally, both the uterus and vagina should be carefully douched with a hot antiseptic solution, such as lysol, a drachm to a quart (temperature 120° Fahr.), and the vagina loosely plugged with iodoform gauze. The strictest antiseptic precautions are called for in performing this simple operation; the vulva should be shaved and swabbed with tincture of iodine, the vaginal walls swabbed with it also, and sterilised rubber gloves should be used by the operator.

Septic Abortion.—Evacuation of the uterus by this method should be practically devoid of risk under ordinary conditions. Occasionally, however, cases come first under treatment after acute septic infection has occurred, and the whole or a part of the ovum is still in the uterus. The greater number of such cases are the work of criminal abortionists. The process of clearing out the uterus is then attended by considerable danger, for in detaching the placenta or membranes blood vessels are laid open into which infective material may find direct access during the operation. In this way the generalisation of the infective process is actually assisted. Nevertheless it is sound practice to follow the surgical rule that actively infected cavities must always be cleared of their contents and freely drained. In performing the operation under these conditions cutting or sharp scraping instruments should be avoided, and the uterus cleared out with the finger alone or aided only by a blunt curette. A septic uterus also should never be plugged, as free drainage is essential.

The *after-treatment* of abortion is conducted upon the same principles as the normal puerperium (p. 542). Women of the poorer classes often pay little or no attention to a miscarriage; they do not seek medical advice, nor do they consider that a subsequent period of rest is necessary. But many forms of chronic pelvic inflammation arise from a neglected miscarriage, and it is the medical man's duty to enforce proper management and an adequate period—at least ten days—of rest in bed.

Death and Retention of the Fœtus in Utero

When an ovum perishes *in utero* during the first three or four months of pregnancy, the cause is usually to be found

in the changes described in connection with fleshy or hydatidiform moles. At a later period it is not infrequent for the fœtus to perish *in utero* from various causes which do

Fig. 96.—A Complete Ovum of Three Months' Development, retained for some weeks after death. (Charing Cross Hospital Museum.)
An opening has been made in the chorion to show the fœtus in the amniotic sac.

not lead to the production of gross anatomical changes in the placenta or membranes (Fig. 96). In cases of acute infection from the maternal blood, as may occur, for example, in typhoid fever, the ovum is usually expelled at once. In other cases the ovum may be retained *in utero* for many weeks

before being expelled, and it then undergoes a series of well-defined changes which are practically the same at all periods of pregnancy. Recent observations have shown that syphilitic changes can be found in a large proportion of such ova.

The results of retention of a dead ovum *in utero* vary with the conditions present. Infection of the ovum is very rare, and is only found in cases where the membranes have ruptured, the liquor amnii has escaped, and an open channel is left through which vaginal organisms may enter the ovum. Under all other conditions the changes are non-infective.

The *embryo* (first and second months) may entirely disappear by autolysis and absorption. At later periods the *fœtus* at first undergoes *maceration* from the action of the surrounding fluid. The epidermis becomes sodden, bullæ form beneath it, and finally it is shed in pieces. Gradual absorption of liquor amnii may then occur, and later of the fluid constituents of the embryonic tissues also. The fœtus then becomes shrivelled, or mummified, the bones standing out clearly beneath the thin integuments. The *fœtus papyraceus* already described exemplifies this change also. During the process of maceration the *liquor amnii* becomes turbid and discoloured ; later it is more or less completely absorbed.

The detailed changes which occur are as follows :—

The body is shrunken and the skin lax and loose. Subcuticular bullæ are formed containing discoloured turbid fluid ; these rupture, and after shedding of the detached cuticle, dark red moist areas of the cutis become exposed. The body cavities contain turbid reddish fluid in moderate quantity. The articular ligaments become softened, allowing free separation of the bones to occur ; thus the trunk may become elongated, and the skull bones may be made to overlap, and ride easily upon one another. The solid viscera are softened and ultimately become diffluent. The umbilical cord is stained and is unusually thick from softening of Wharton's jelly. The liquor amnii is relatively scanty in amount and discoloured. The placenta is often extensively infarcted, but this is an ante-mortem change. Its tissues do not soften and liquefy like those of the fœtus. Attempts have been made, without much success, to obtain evidence

of the rate at which these changes progress, but up to the present time no reliable data can be given. Occasionally absorption into the maternal circulation of toxic products occurs, giving rise to fever, debility, malaria, and other more or less definite symptoms of toxæmia.

The *placenta* and *membranes* undergo non-putrefactive necrosis, the extra-placental structures being first affected. The umbilical vessels on the placental surface become thrombosed. The placental tissues preserve their vitality much longer, because the maternal circulation is only gradually cut off, and the villi therefore remain in contact with the normal source of their nutrition. Gradually, however, the inter-villous spaces become blocked by thrombosis, the villi necrose and lose all traces of their characteristic structures, until they become mere areas of structureless *débris*, preserving only their original shape. Lastly, extensive fatty and calcareous degenerations occur in all the tissues. In ova altered in this manner by post-mortem changes, it is extremely difficult to determine the primary lesion which caused the death of the fœtus.

The clinical *diagnosis* of death of the fœtus *in utero* can only be established by repeated examinations. The most reliable sign is cessation of growth of the uterus, and at least a fortnight is required to determine this with certainty, the normal rate of growth being about ½ inch a week. Often an actual diminution in size, from absorption of the fluid portion of the ovum, can be made out after some weeks. The uterus is usually lax and flaccid, and it is difficult to excite contractions by manipulating it. During the last three months absence, on repeated examinations, of the heart-sounds is important, but no conclusion can be drawn from failure to hear them on a single occasion. Resolution of breast-changes can sometimes be made out, and is often remarked by the patient herself. Cessation of fœtal movements will be observed by the mother, but these must not be accepted as conclusive evidence unless confirmed by other signs. Other symptoms, such as a feeling of weight and cold in the abdomen, slight shivering, and slight general malaise may be complained of. Sometimes a brownish discharge from the uterus is observed, consisting of the liquefied *débris* of blood-clot or decidual tissue, but it is extremely rare for a

dead ovum to undergo putrefaction *in utero*, except as the result of intra-uterine manipulation.

The *treatment* is expectant in non-infective cases. Spontaneous expulsion will occur sooner or later, and there is no reason for interference except the patient's natural desire to get her labour over. At the same time it must be remembered that local signs of putrefaction render necessary immediate evacuation of the uterus.

Part III

NORMAL LABOUR

Labour is the process by which a fœtus of viable age is expelled from the uterus. Labour varies greatly in duration, in severity, and in the amount of risk to mother and child which it involves. By a *normal labour* is meant a case in which the fœtus presents by the vertex, and which terminates naturally, without artificial aid and without complications. Presentation is not the only criterion of normal labour, for even when the presentation is normal, complications may arise which carry the case at once into the category of *abnormal labour*. It follows that abnormal labour is somewhat difficult to define, but for practical purposes we may include under this designation all cases in which some other part than the vertex presents, and all vertex cases in which complications of maternal or fœtal origin arise.

Within the class of *normal labour* many conditions must be recognised which affect the degree of difficulty which may be encountered. Generally speaking a first labour is more prolonged and more difficult than subsequent ones ; a woman in her first labour is conveniently designated as a *primipara*, in later confinements as a *multipara*. Another factor of considerable importance is *age ;* from eighteen to twenty three years is the age at which the first labour may be expected to run the easiest and most favourable course. A primipara of over twenty-six years of age encounters greater risks, which steadily increase in gravity as age advances. From sixteen to eighteen years of age the difficulties are not materially greater than normal, but below sixteen there is more risk of serious laceration.

The *date* at which labour may be expected is difficult to determine. The average duration of pregnancy in women is generally believed to be forty weeks. This, however, is an estimate which is necessarily approximate not precise. The moment at which pregnancy begins, *i.e.*, the fertilisation of

the ovum, cannot be determined, and it is here that abundant room for error must be admitted. The data available in determining the beginning of pregnancy are : (1) the last menstrual period ; (2) the sexual congress. It has been already mentioned that the relation of the former to the act of fertilisation is quite unknown ; the relation of the latter is of service only when a single act of coitus has occurred, and even then we do not know how long an interval may have elapsed between the deposition of the spermatozoa in the vagina and the fertilisation of the ovum. For practical purposes therefore these data cannot be relied upon, and allowance must be made in the estimate for the unavoidable inaccuracy. The 'calculated' date at which labour may be expected is taken to be 280 days (forty weeks) after the commencement of menstruation. This must not, however, be regarded as an exact date, but as the central point of a period of probability ranging from the 274th to the 286th day. The calculation may be made as follows : Last menstruation January 31 to February 5.

February	28 (if leap year, 29)
March	31
April	30
May	31
June	30
July	31
August	31
September	30
October	31
November	7
	280

Therefore the confinement may be expected to take place between November 2 and 12. Labour may occur at an earlier period than forty weeks when it is said to be *premature ;* many of such cases are due to pathological conditions, but sometimes no cause can be assigned. On the other hand the onset of labour may be delayed considerably beyond the normal period, when it is said to be *postmature.* It is very uncommon for the calculated duration of pregnancy to

exceed 300 days, but an instance has been recorded by von Winckel in which it was 322 days. Owing to the difficulties referred to above an exact estimate of postmaturity is impossible. Calculation may, however, be controlled by two other factors : (*a*) the length and weight of the fœtus, which considerably exceed the normal ; (*b*) the condition of the fœtal centres of ossification as determined by radiography ; these have been worked out by Keith for the normal fœtus at term, and a considerable advance upon his data may be accepted as evidence of postmaturity. The details cannot be discussed here.

It is obvious that while the birth of a premature child will be easier, the delivery of a child whose weight and size greatly exceed the normal will be attended by increased risks, and consequently the subject of postmaturity is not without clinical importance. It will be again referred to in connection with the induction of premature labour (p. 653).

The Onset of Labour.—The signs by which the onset of labour is recognised must be clearly understood. They are (1) painful uterine contractions ; (2) slight uterine hæmorrhage—the 'show' ; (3) commencing dilatation of the internal os ; (4) formation of the 'bag of waters.'

(1) *Painful Uterine Contractions* (Labour Pains).—Reference has already been made to the fact that during the second half of pregnancy intermittent contractions, recognisable on palpation, occur in the wall of the gravid uterus. The patient is unconscious of them, and they produce no effect upon the cervix or ovum. At 'term' these contractions change their character and become labour pains ; usually the transformation is gradual, vague transient abdominal pain being complained of by the patient for several days ; sometimes, however, a rapid or sudden onset of labour pains will be met with. At first they are slight, lasting for only half a minute, and separated by intervals of fifteen to thirty minutes ; they are then felt chiefly in the abdomen. More or less rapidly they increase in frequency, severity, and duration. If the abdomen is palpated during a pain, the whole uterus will be felt to harden and become more clearly defined in outline.

In women expecting to be confined, colicky abdominal pains, which may sometimes be mistaken by the patient for

labour pains, are apt to occur from such trivial causes as dyspepsia and constipation. They have received the somewhat inept name of ' false pains.' Pain of this description is not accompanied by dilatation of the internal os or contrac-

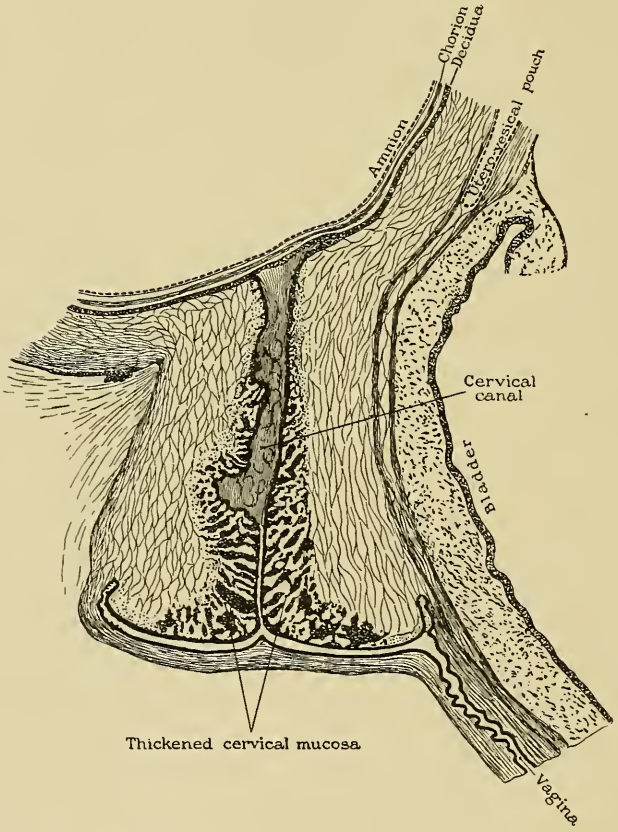


Fig. 97.—Cervix of a Multipara at Term, before Commencement of Labour. From a Frozen Section. (Varnier.)

tion of the uterus, and need therefore never be mistaken for labour ; it is best treated by an aperient or an enema.

(2) *The ' Show '* is a discharge of slightly blood-stained mucus. The mucus comes from the cervical mucosa, which secretes abundantly during labour ; the slight hæmorrhage comes from the lower uterine segment, where the commencement of dilatation causes a little separation of the

membranes. It is almost invariably met with at the onset of labour. . .

(3) *Dilatation of the Internal Os.*—The usual condition of the cervix at term, before the onset of labour, is shown in Fig. 97. From this figure it will be seen that the cervix is not shortened ; the canal is intact and closed at both ends. In a multipara the external os is sometimes patulous, admitting the tip of the index finger, but even then the internal os will usually be found closed before labour. The alterations induced by the onset of labour are shown in Fig. 98, where it will be seen that the cervix is shortened, and the canal open

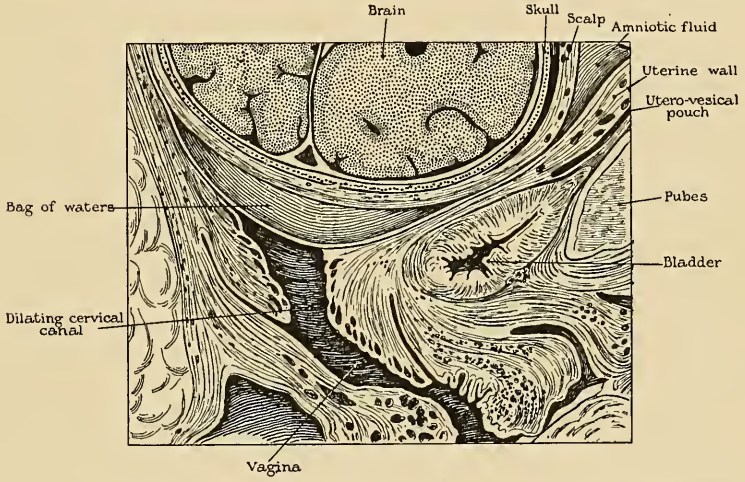


Fig. 98.—Cervix of a Multipara who died of Eclampsia at the beginning of Labour. From a Frozen Section. (Varnier.)

at both ends, the internal os being rather wider than the external. These figures represent the actual conditions found in frozen sections of women who died, the former before labour, the latter soon after its commencement ; they have therefore the value of precise anatomical observations. It will be noticed that the dilatation of the internal os is of necessity accompanied by a corresponding stretching of the lowest part of the lower uterine segment. Notwithstanding what has just been said, the internal os is not infrequently found dilated sufficiently to admit the finger tip in women who are not in labour ; this is more frequently found in a multipara than in a primipara. In some cases it is the result

of a false start, a few effective pains having occurred and then died away. In others there is no history of definite pains having been felt, and this slightly patulous condition of the internal os may appear two or three weeks before labour actually sets in.

The position is, therefore, that, while a closed cervix is a reliable sign that labour has not begun, a slightly patulous cervix may be found in a woman who is not in labour.

(4) *Formation of the 'Bag of Waters.'*—When the cervix opens, the lower pole of the fœtal membranes (chorion and amnion), which has been already detached by stretching of the lower uterine segment, being unsupported, tends to bulge into the cervical canal. It contains a little liquor amnii which has passed below the presenting part, and it has therefore received the name of the 'bag of waters.' When the finger is passed into the cervix during a pain, this bag will be found to be convex in outline and tense in consistence; as the pain passes off it becomes less tense and less distinct, and may even disappear altogether as the membranes come into contact again with the head.

Notwithstanding these points, it is at times somewhat difficult to decide from a single examination whether a patient is actually in labour or not. Pains sufficient to open the internal os may occur and then cease, several days or even two or three weeks elapsing before the actual onset of labour. Again, the patient may complain of intermittent pains, and uterine contractions may actually be felt on palpation, yet there may be no dilatation of the cervix at all. It follows that neither painful contractions alone, nor dilatation of the cervix alone, suffices for recognising that labour is actually in progress. But if with intermittent pains and dilatation, the bag of waters is felt to grow tense during the pain, and to relax during the interval, the diagnosis of labour is certain. Yet after labour has actually begun the process is sometimes suspended, and the pains do not start again until an interval of several days has elapsed.

The Stages of Labour.—In this country it is usual to divide the process of labour into three stages. In most instances these stages can be clinically defined with approximate accuracy, but sometimes cases occur in which this is impossible.

First Stage, or Stage of Dilatation.—This stage is preparatory to the actual process of birth—*i.e.*, the expulsion of the fœtus from the uterus. It consists in the dilatation or canalisation of the lower uterine segment and cervix. Clinically its progress can be judged by the changes taking place in the os externum, the cervix, and the bag of waters.

Even when in a multipara the external os is patulous at the commencement of labour the vaginal portion of the cervix is distinctly felt forming a projection of about half an inch in length. As the internal os opens the upper part of the cervical canal becomes merged in the lower uterine segment; as the dilatation progresses, more of the cervix becomes thus 'taken up' into the uterus, and this change can be detected by the finger as a shortening of the cervical projection on vaginal examination. When no definite cervical projection can be felt the cervix is said to be 'taken up,' although the external os may still be only partially dilated. In a primigravida the os externum sometimes remains very small after the cervical canal has become merged in the lower segment; the head then distends the cervical canal, the walls of which become tightly stretched over it. The os is then felt as a small aperture with firm edges upon the summit of the convexity formed by the distended cervix, which has been completely 'taken up.' But as a rule the bag of waters bulges slightly through the dilating external os in the shape of an inverted watch-glass (Figs. 98 and 99); the amount of fluid it contains varies considerably, and upon this its size and shape depend. During the intervals when the bag is lax the fœtal head can be distinctly felt through it. When, as sometimes happens, the membranes rupture before the onset of labour, no bag is as a rule formed, although exceptions to this may be met with (see p. 453). When dilatation is complete the diameter of the cervical canal is nearly four inches, the presenting part occupies the whole cervical canal, and the edges of the os externum can be felt surrounding it. At this period the bag of waters usually ruptures spontaneously, and a certain amount of liquor amnii escapes, but the greater part is retained in the uterus, the presenting part filling the lower uterine segment and thus acting as a ball-valve. Sometimes, however, rupture of the membranes occurs prematurely in the first stage; or

on the other hand, it may be delayed until the second stage is considerably advanced; in exceptional cases it may not occur at all, the bag protruding at the vulva and the head being still enclosed in the membranes. As a rule, however, in such cases the chorion ruptures, allowing the amnion to protrude through it, and it is the latter membrane alone which presents at the vulva.

The duration of this stage is variable, being usually

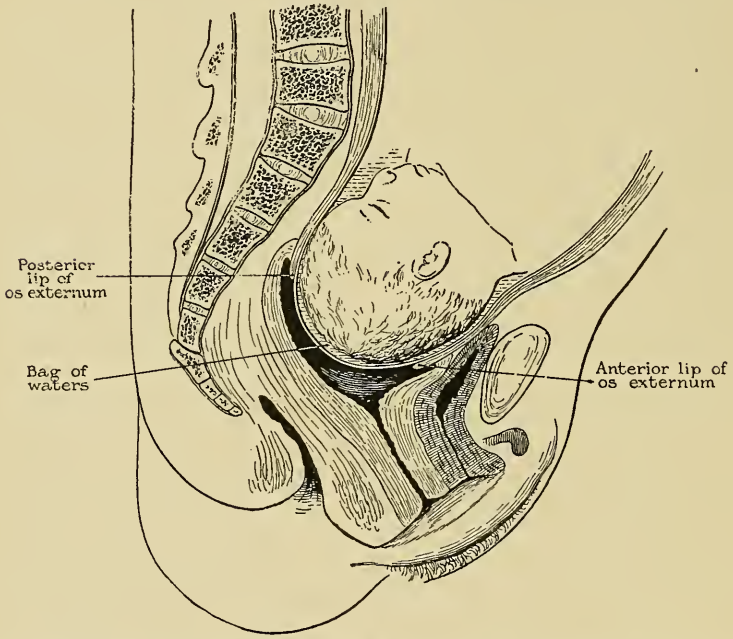


FIG. 99.—End of the First Stage of Labour. The Lower Uterine Segment, Cervix, and Upper Part of the Vagina are dilated. (Modified from Ribemont-Dessaignes and Lepage.)

much longer in a primipara than in a multipara. Its average may be stated as sixteen hours in the former, and eight hours in the latter. The patient suffers throughout from intermittent pain, felt chiefly in the abdomen, occurring at more or less regular intervals of from three to five minutes; frequently there is vomiting in this stage, but the pulse and temperature remain normal.

Second Stage, or Stage of Expulsion.—This stage begins at the time when dilatation of the cervix is complete, whether

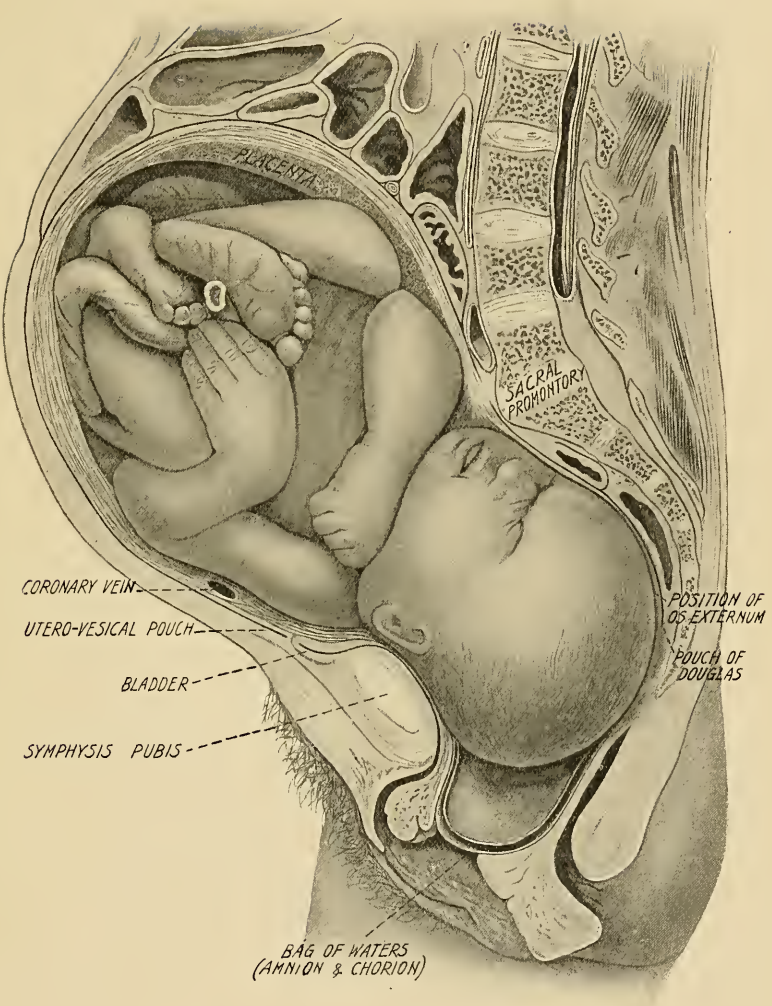


FIG. 100.—Section showing the Second Stage of Labour. The Os is fully dilated, and the unruptured Bag of Waters presents at the Vulva. The Uterus is thrown forwards away from the Spine, and no Sinuses are seen in the Uterine Wall, showing that death occurred during a contraction and passed into rigor mortis.[1] (Braune, from Barbour's Anatomy of Labour.)

[1] *Note.*—Flexion is deficient; the right arm lies under the chin; internal rotation is nearly complete.

accompanied by rupture of the membranes or not ; it ends with the complete expulsion of the child from the birth-

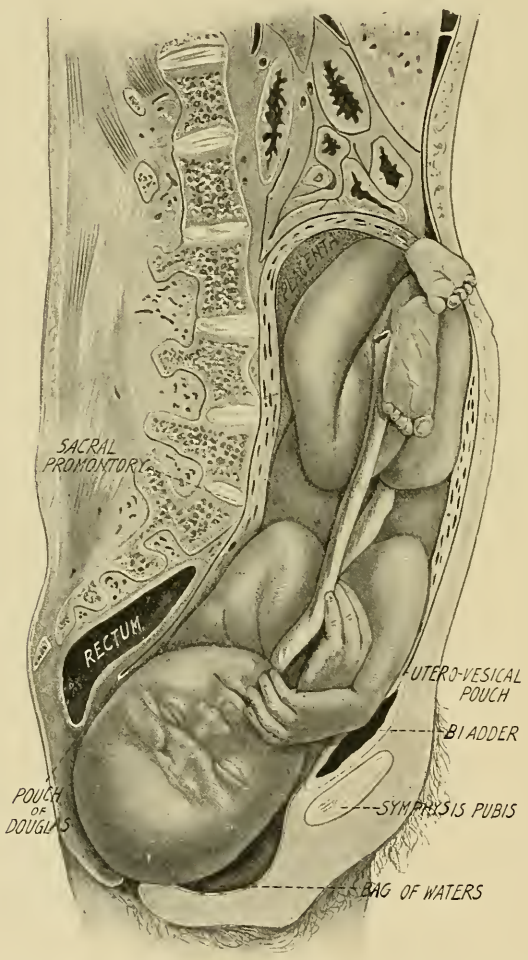


Fig. 101.—Section showing the End of the Second Stage of Labour. The Axis of the Uterus is parallel to the Spine, and the Sinuses in the Wall are open, showing that death occurred during relaxation.[1] (Chiara, from Barbour's Anatomy of Labour.)

canal. The presenting part is now passing from the cervix into the vagina, and on examination the lip of the os

[1] *Note.*—Flexion is deficient ; the head lies in the transverse diameter.

externum cannot be felt posteriorly, but is still within reach anteriorly. It will be observed that during this stage the vagina becomes gradually dilated from above downwards (Fig. 100) by the passage through it of the head and body of the fœtus. The condition of the birth-canal towards the end of the second stage, but before the actual expulsion of the child, is seen in Fig. 101, which shows that the uterus,

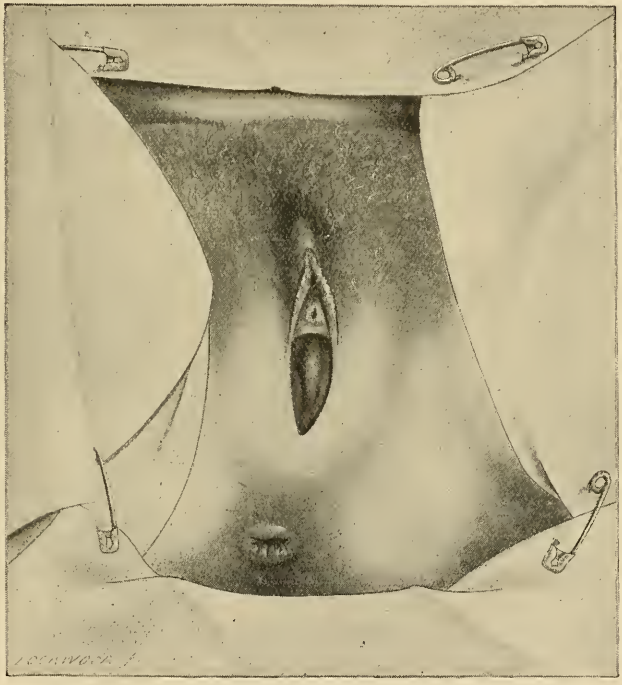


Fig. 102.—Birth of Head: Scalp appearing at Vulva.
(Whitridge Williams.)

cervix, and vagina have been merged into a single broad channel, the boundaries between the component parts having been obliterated.

The expulsion of the child is accomplished by the uterus, strongly reinforced by the voluntary muscles, which are vigorously used by the patient. The participation of the voluntary muscles is the chief factor in causing the characteristic feature of the pains of the second stage. The onset

of each pain is accompanied by a deep inspiration, followed by straining or ' bearing down,' in which the patient holds her breath and employs her diaphragm, abdominal and back muscles, and sometimes apparently all the muscles in her body. The face becomes congested, the pulse quickened, she perspires a little and groans deeply during the pains. They

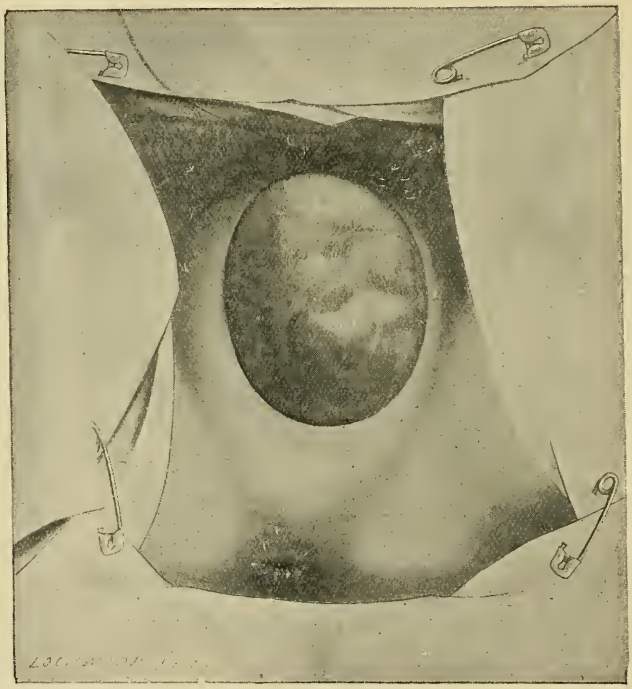


Fig. 103.—Birth of Head : Vulva completely dilated.
(Whitridge Williams.)

last much longer and recur more frequently than those of the first stage.

When the head reaches the pelvic floor, the first change observed in the external genitals is stretching of the perineal body, which during the pains becomes somewhat convex externally and lengthened from anus to vulva (Fig. 102). Next the anus becomes turgid and dilates slightly, and the hairy scalp appears at the vulva (Fig. 103). As each pain passes off, the parts resume their normal appearance. When

the head is about to emerge the anus gapes widely, exposing one to two inches of the anterior rectal wall. The fourchette becomes greatly thinned as the vulva stretches, and a certain amount of laceration of the posterior wall of the ostium vaginæ may be expected to occur. This usually also involves the lower part of the posterior vaginal wall and at times the perineal body, which may in some instances be torn up to or including the anus. The actual expulsion of the head in a primipara is accomplished by a very prolonged and severe contraction, or by a series of powerful contractions, accompanied by violent straining.

A short pause then occurs, to be succeeded in two or three minutes by a return of the pains, which expel first the shoulders, and then the trunk and lower extremities. In the case of a large fœtus, the expulsion of the shoulders may cause as much laceration of the vulva as the delivery of the head. As the body escapes a rush of blood-stained liquor amnii follows, representing the portion of fluid which has been retained in the uterus along with the trunk and limbs. The second stage lasts on an average three hours in a primipara; in a multipara it is often very short, lasting only ten to fifteen minutes when the uterus acts powerfully; but it may last very much longer than this when the pains are relatively feeble.

Third Stage, or Delivery of the After-birth.—The after-birth consists of the placenta, umbilical cord, and membranes; the latter include the amnion, chorion, and sometimes the remains of the decidua vera.

Following upon the expulsion of the fœtus, the uterus undergoes a sudden and striking diminution in size. The fundus now lies about the level of the umbilicus, and the uterus appears to be about as large as the fœtal head. It will be observed to vary gradually in consistence, becoming alternately harder and softer to the touch; this signifies that intermittent contractions are continuing, but they are practically painless, and the patient is usually unconscious of them. After a period varying on an average from ten to thirty minutes, certain changes occur which indicate that the placenta has been detached from the uterine wall and driven into the lower uterine segment and cervix, or into the vagina. The uterus becomes smaller, harder, more globular in shape,

and more freely movable from side to side ; the level of the fundus, which is hard and retracted, rises, while the lower segment, now plainly felt above the pubes, is soft and bulging from the presence in it of the placenta. It may also be noticed that the length of the umbilical cord lying outside the vulva is greater than before. A certain amount of hæmorrhage always accompanies the process of separation of the placenta. Expulsion is usually accomplished by a voluntary effort on the part of the patient, when the placenta appears at the vulva, and can be withdrawn by the attendant ; a considerable amount of blood-clot often follows it.

The uterus is now about the size of a cricket-ball, and should remain almost uniformly firm and hard ; but for some hours after labour intermittent spontaneous contraction and relaxation can often be recognised, and while these continue there is a risk of hæmorrhage.

The Anatomy and Physiology of the First and Second Stages of Labour.

In this section will be described (I.) the maternal passages and the effects of labour upon them ; (II.) the fœtus at term and the effects of labour upon it ; (III.) the forces of labour, their mode of action, and their influence upon the general physiological functions of the mother.

I. The Maternal Passages.—These comprise the bony canal with the soft structures which line it and close in its outlet.

A description of the general anatomy of the pelvis is unnecessary in a text-book of midwifery ; it will, however, be useful to recall the points of difference between the male and female pelvis (Figs. 104 and 105). In the female the bones are more slender and the muscular impressions less pronounced. The false pelvis (the part above the pelvic brim, and bounded laterally by the iliac bones) is somewhat more capacious in the female than in the male, the anterior superior iliac spines being a little further apart, and the iliac fossæ looking more directly forwards. In the female the true pelvis is somewhat more capacious, though a little shallower ; the sacral promontory projects less into the brim ; the sacrum is rather less concave anteriorly ; the pelvic outlet is considerably larger

in all its diameters, and the pubic arch forms a much more obtuse angle. Sometimes a female pelvis approximates to the male characteristics, leading to a certain amount of difficulty in labour.

With the *false* pelvis we have little concern except that its dimensions are of service in indicating the shape and size of the true pelvis ; these will be mentioned in describing clinical pelvimetry (p. 401). The *true* pelvis is divided for

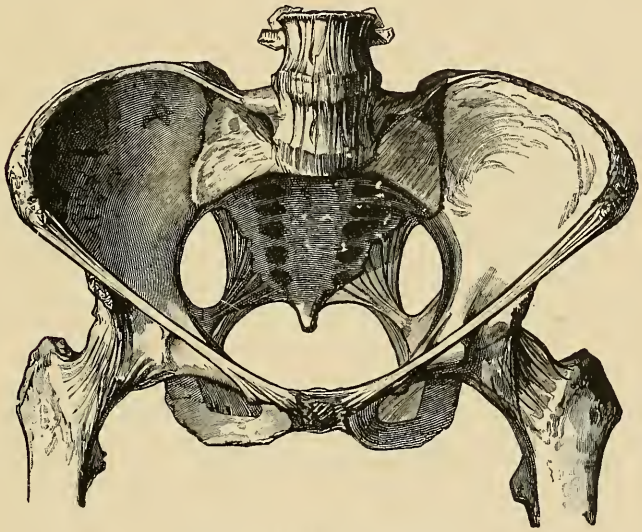


Fig. 104.—Female Pelvis.

systematic description into three parts—viz., the *brim*, the *outlet*, and the *cavity*.

The *pelvic brim* or *inlet*, or *upper pelvic strait*, is the plane of division between the false and the true pelvis (Fig. 106). It may be traced from the centre of the upper border of the symphysis pubis (*b*), along the pubic crest, past the pubic spine to the ilio-pectineal eminence (*f*), thence along the iliac portion of the ilio-pectineal line to the sacro-iliac synchondrosis (*g*), thence along the ala of the sacrum to the centre of the sacral promontory (*a*). Its shape is that of a transverse oval, with a slight posterior constriction caused by the promontory of the sacrum (*i.e.*, it is roughly cordate, Fig. 110). We have to consider its *plane*, its *inclination*, its *axis*, and its

diameters. The *plane* of the pelvic brim is an imaginary flat surface bounded by the limits just mentioned as those of the brim ; it is convenient to speak of the presenting part of the fœtus as lying above, or below, or in the plane of the brim. The plane of the brim is not, in the erect position of the body, a horizontal surface, but, owing to the oblique articulation of the pelvis with the femora, it is inclined at an acute angle to the horizon ; this is its *inclination.* This will be clear from Fig. 107 (*a*), which represents a bisected pelvis, placed

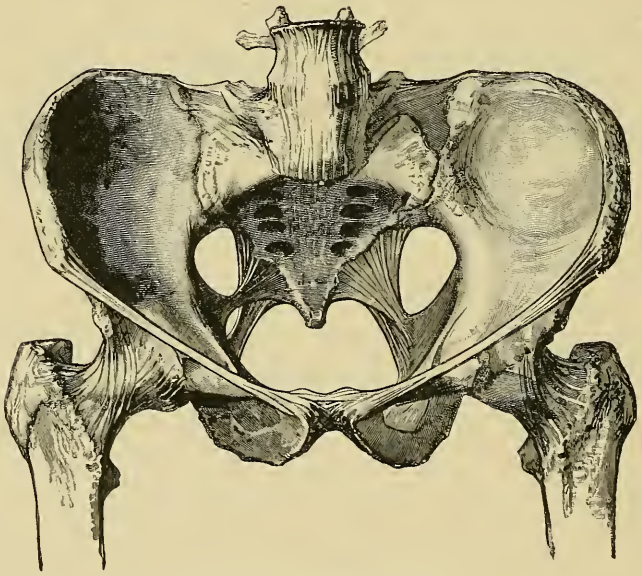


Fig. 105.—Male Pelvis.

in the position it would occupy in the erect attitude. The general inclination of the line of the brim is well seen. The same points are shown diagrammatically in Fig. 107 (*b*), which shows that the angle of inclination in the erect position is 55°. The posterior border of the brim accordingly stands at a higher level than the anterior, the sacral promontory being about $3\frac{3}{4}$ inches above the upper border of the symphysis pubis in the erect position. It must also be observed that the surface of the body of the pubes is not vertical, but almost at right angles to the plane of the brim. The *axis* of the brim will be represented by an imaginary

straight line drawn perpendicular to the plane of the brim at its centre ; this being produced upwards and downwards, will pass from the umbilicus to the tip of the coccyx (Fig. 109). This line indicates the direction in which a body passing through the pelvic brim must travel. Four *diameters* of the pelvic brim are described ; it must be recollected that they are skeletal measurements and represent averages from which slight variations in both directions occur. The antero-posterior diameter or *conjugate* is measured from the centre of the sacral promontory behind to the nearest point

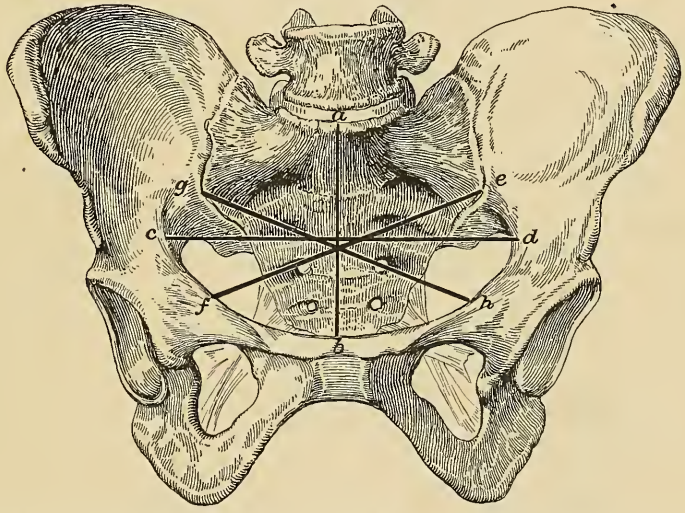


FIG. 106.—The Female Pelvis: Outline of Pelvic Brim, *a*, *e*, *d*, *h*, *b*, *f*, *c*, *g*.
a, *b*. Conjugate diameter. *c*, *d*. Transverse diameter. *e*, *f*. Left oblique diameter. *g*, *h*. Right oblique diameter.

in the middle line upon the posterior surface of the symphysis pubis in front (Fig. 106, *a*, *b*). This diameter is also called the *obstetric* or *true conjugate*, to distinguish it from certain clinical measurements to be afterwards described, which are also called conjugates. The two *oblique* diameters are measured from the sacro-iliac synchondrosis behind to the ilio-pectineal eminence on the opposite side ; the right oblique is that taken from the right sacro-iliac joint (*g*, *h*), the left from the left sacro-iliac joint (*e*, *f*). A *transverse* diameter is also described, being the distance between the two furthest apart points of the pelvic brim (*c*, *d*) ; this line

lies nearer the sacrum than the pubes, and is not, strictly speaking, a *diameter* at all since it does not pass through the centre.

The *pelvic outlet* or *lower pelvic strait* is a lozenge-shaped space bounded in front by the lower border of the symphysis pubis ; laterally by the pubic arch, the ischial tuberosities, the ischial spines, and the greater and lesser sacro-sciatic ligaments ; posteriorly by the coccyx (Fig. 108). These

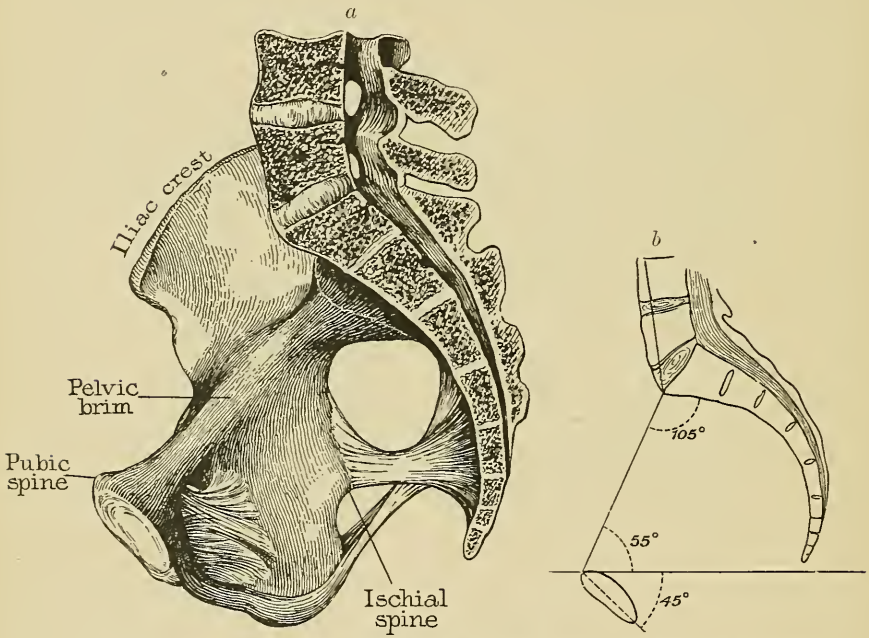


Fig. 107.—(*a*) A Bisected Pelvis, as in the Erect Position, showing the Inclination of the Pelvic Brim. (*b*) The same represented Diagrammatically.

boundaries do not lie in a single plane ; hence, strictly speaking, the *plane of the outlet* does not exist, for its lateral boundaries lie at a lower level than the front and back. It is of great practical importance, however, to determine the *axis* of the outlet, and it has consequently been agreed to describe its *plane* as the imaginary flat surface bounded in front by the lower border of the symphysis, laterally by the tips of the ischial spines, and posteriorly by the lower border of the last sacral vertebra. As thus defined, its shape is that

of an antero-posterior oval (Fig. 110). Its *axis* will be represented by a line joining the centre of its plane with the sacral promontory—a line much more nearly vertical than the axis of the brim (Fig. 109). Only two diameters can be described: the *antero-posterior*, taken from the centre of the lower border of the symphysis to the tip of the last sacral vertebra (Fig. 108); and the *transverse* between the inner borders of the ischial tuberosities. Oblique diameters cannot be defined, as between the ischial tuberosities and the coccygeal border

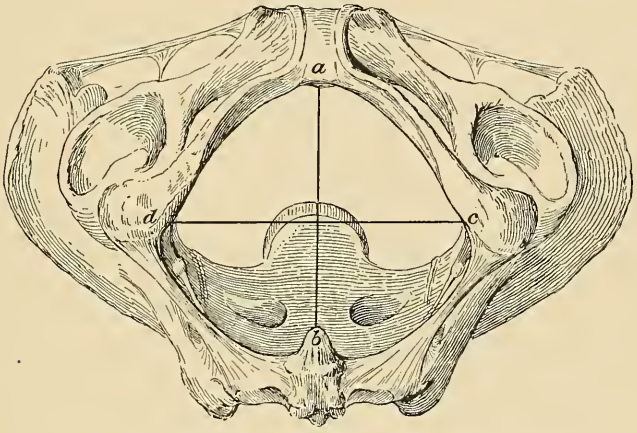


FIG. 108.—The Pelvic Outlet: Lower Pelvic Strait.
a, *b*. Antero-posterior diameter. *c*, *d*. Transverse diameter.

the pelvic outlet is filled in with soft structures only, and the diameters we are considering are skeletal.

It will be obvious that the length of antero-posterior diameter is reduced by the forward projection of the coccyx in the skeleton. During labour, however, the movement of the coccyx at the sacro-coccygeal joint carries it backwards, so that the length of the diameter is not much affected. When the sacro-coccygeal joint is ankylosed this movement cannot occur and the available diameter is reduced.

The *pelvic cavity* is the space between the plane of the brim above and the plane of the outlet below. It forms a curved canal with a shallow anterior and a deep posterior wall; the former measuring $1\frac{1}{2}$ inches, the latter $4\frac{1}{2}$ inches; its lateral walls are about 4 inches deep. It is obvious that a number of *planes* of the cavity, taken at different levels,

might be described, but it suffices to determine a single one—the *mid-plane*, bounded in front by the centre of the symphysis pubis, and behind by the junction of the second and third sacral vertebræ. Its shape is intermediate between that of the brim and that of the outlet (Fig. 110). Its *antero-posterior diameter* is measured from the points just mentioned, its *transverse diameter* across the widest part; *oblique diameters* cannot be precisely defined, owing to the soft structures filling in the sacro-sciatic notches. The *axis* of the

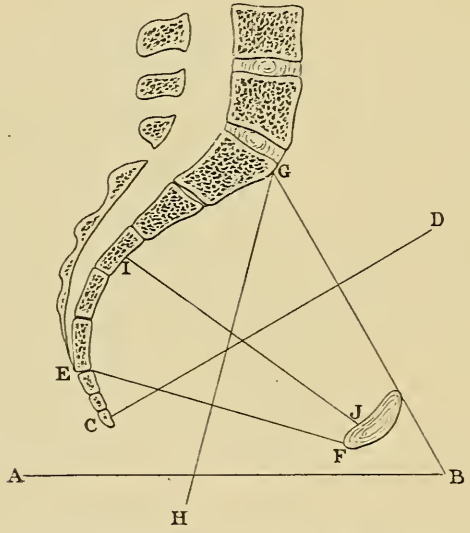


FIG. 109.—The Planes and Axes of the Normal Pelvis.

A, B. Horizontal line. G, B. Plane of the brim. J, I. Plane of the mid-cavity. F, E. Plane of the outlet. D, C. Axis of the brim. G, H. Axis of the outlet.

mid-plane of the cavity is represented by a line, the direction of which is intermediate between those of the brim and the outlet. By uniting the axes of the three planes of the brim, mid-cavity, and outlet, a line is formed which will traverse the centre of the canal of the bony pelvis (Fig. 112). It forms a curve, concave anteriorly, and directed at first downwards and backwards (axis of brim), then gradually more and more forwards until it reaches the axis of the outlet. It is of great service in the systematic description of labour, but does not strictly follow the centre of the canal, as no allowance is made for the irregular curvature of the

anterior surface of the sacrum. This line is known as the *axis of the pelvis* or curve of Carus; in labour it becomes modified by displacement of the pelvic floor, and will be again referred to in that connection.

The average length of the diameters of the bony pelvis is as follows:

	Ant.-Post.	Oblique.	Transverse.
Brim (plane) . .	$4\frac{1}{4}$ in. (10·5 cm.)	$4\frac{3}{4}$ in. (12 cm.)	$5\frac{1}{4}$ in. (13 cm.)
Cavity (mid-plane)	$4\frac{3}{4}$,, (12 ,,)	5 ,, (12·5 ,,)	$4\frac{3}{4}$,, (12 ,,)
Outlet (plane) .	$5\frac{1}{4}$,, (13 ,,)	$4\frac{1}{2}$,, (11·5 ,,)	$4\frac{1}{4}$,, (10·5 ,,)

The oblique diameters of the cavity and outlet are approximate, for the reasons already mentioned. The

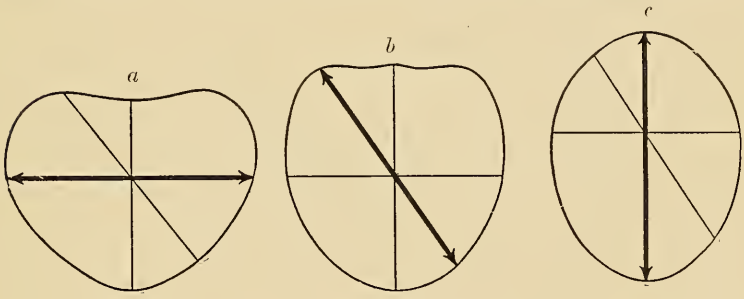


FIG. 110.—The Planes (*a*) of the Brim, (*b*) of the Cavity, (*c*) of the Outlet.
The double-headed arrow represents the longest diameter.

antero-posterior diameter of the outlet is clinically measured from the lower border of the symphysis to the tip of the coccyx instead of to the lower border of the last sacral vertebra. With the coccyx pushed back to the fullest possible extent in the position it assumes in normal labour when the fœtal head passes through, it measures $5\frac{1}{4}$ inches; with the coccyx in its normal position it is $\frac{3}{4}$ to 1 inch less than this.

These diameters are reduced by the soft structures which line the pelvic walls and by the viscera contained within the pelvis. The ilio-psoas and obturator internus muscles reduce the transverse and oblique diameters at the brim. The pelvic colon and upper part of the rectum lie in the left oblique diameter both of the brim and the cavity; in parturient women the conjugate of the brim passes through the

urethra and through both walls of the cervix, which diminish the space available for the accommodation of the presenting part of the fœtus. Frozen sections show that in the second stage the available space in the conjugate diameter is thus diminished, at the brim from $\frac{1}{4}$ to $\frac{1}{2}$ inch, in the cavity from $\frac{1}{2}$ to $\frac{3}{4}$ inch.

The *pelvic floor* comprises the soft parts which fill in the pelvic outlet. For a general description of the structures of which it is composed a text-book on anatomy should be

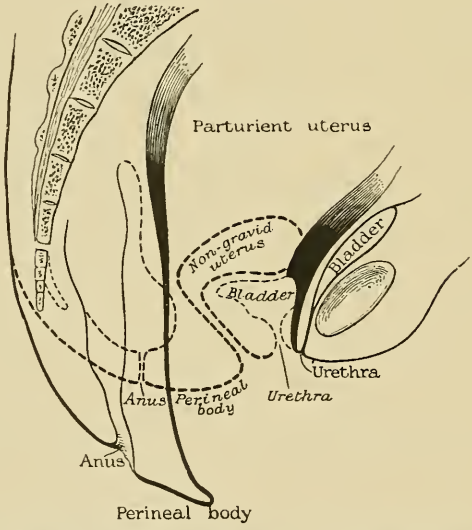


Fig. 111.—Schematic Representation of the Displacement of the Pelvic Floor in Labour. (Dakin.)

consulted ; we are only concerned with the changes which it undergoes during labour.

Under ordinary conditions the outer or lower surface of the pelvic floor (the anatomical *perineum*) is somewhat convex, the centre of the perineal body being $1\frac{1}{4}$ inch below the level of a line joining the lower border of the symphysis with the tip of the coccyx. The usual *projection* of the pelvic floor is, therefore, $1\frac{1}{4}$ inch. Three canals pierce it—viz., the urethra, the vagina, and the rectum (Fig. 111). The central canal, the vagina, becomes enormously dilated during the second stage of labour, and in consequence the whole disposition of the pelvic floor is altered (Fig. 112). The dilatation

of the vagina divides the pelvic floor into two sections : the anterior section, lying in front of the vagina, becomes drawn upwards and forwards ; the posterior section, lying behind it, becomes displaced downwards and backwards, and the fœtus is expelled through the space thus opened up between them. The process has been aptly likened by Berry Hart to the act

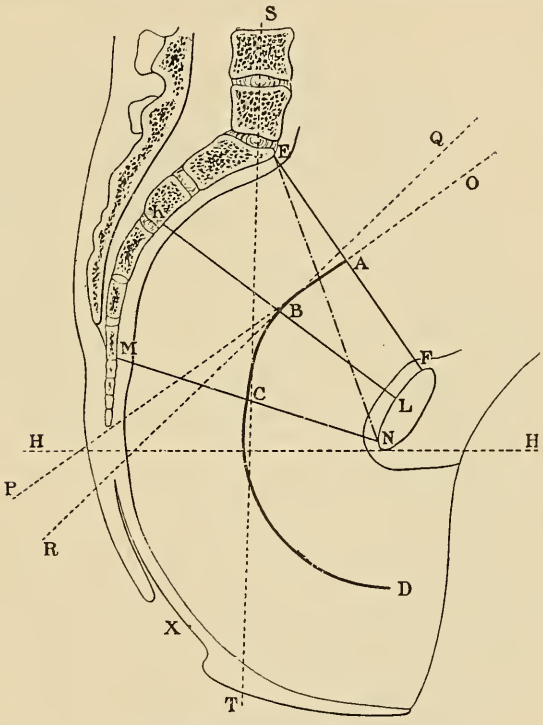


Fig. 112.—The Pelvic Axis. (Galabin.)

E, F. Conjugate of the brim. E, N. Diagonal conjugate. L, K. Conjugate of the cavity (mid). N, M. Conjugate of the outlet. O, P. Axis of the brim. Q, R. Axis of the cavity. A, B, C, D. The pelvic axis. H, H. Horizontal line. S, T. Vertical line. X. Anus.

of passing through swing doors by pulling one door towards you and pushing the other away. The upward displacement of the anterior section is indicated by the alteration which occurs in the position of the urethra and bladder during the second stage of labour. During the first stage it remains a pelvic organ, and lies behind the symphysis pubis (Fig. 99) ; in the second stage it becomes drawn up above the pubes into the abdomen, while the urethra is correspondingly elongated

(Fig. 100). The displacement of the posterior section has been described in connection with the clinical phenomena of the second stage of labour. The effects produced are diagrammatically shown in Fig. 112. The fourchette is now the lowest part of the pelvic floor; it lies 4 inches below the coccygo-symphysial level; the *projection* of this portion of the pelvic floor has therefore been increased to 4 inches, and a

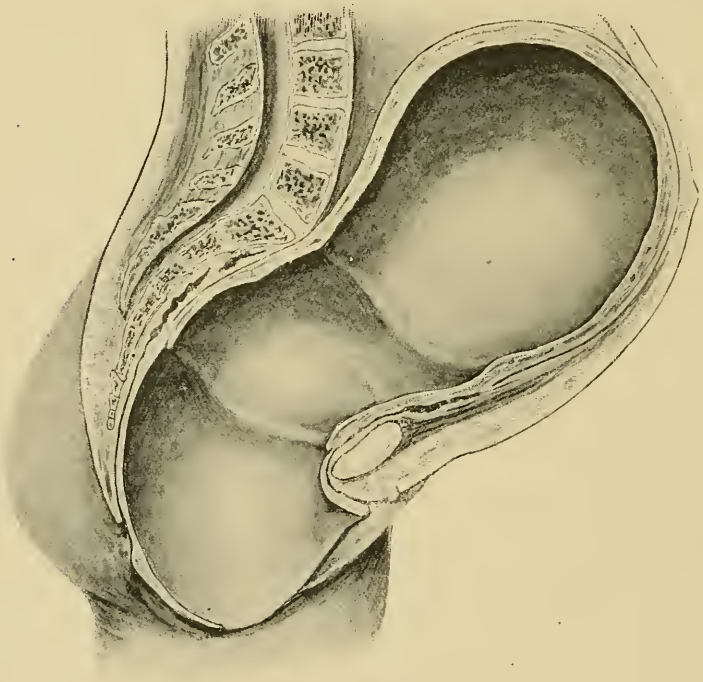


FIG. 113.—The Fully Dilated Parturient Canal. (Galabin and Blacker.)

wide aperture of exit provided for the fœtus. The effect of this displacement is to prolong the pelvic canal by the formation of a tube composed solely of soft parts below the level of the pelvic outlet; this prolongation, like the cavity of the true pelvis itself, has a shallow anterior wall, but deep posterior and lateral walls. Its relation to the bony canal is diagrammatically shown in Fig. 113, from which it will be seen that the axis of the prolongation forms a continua-

tion of the axis of the bony pelvis. The path to be followed by the fœtal head in passing through the pelvis is accordingly represented in full by the curved line A, B, C, D, representing the *axis of the pelvis* (Fig. 112).

The most important of the structures which make up the

FIG. 114.—Fœtus showing the Normal Attitude of Flexion. (Barbour.)

pelvic floor are the pelvic fascia and the levator ani muscle. The former is the visceral layer which springs from the fascia clothing the lateral pelvic wall at the level of the *white line* which corresponds to the level of the ischial spine (Fig. 107). Attached to the lower surface of the pelvic fascia and arising from it, are the fibres of the levator ani. These

two structures form a diaphragm closing in the pelvic cavity below, inasmuch as from each side they pass downwards and inwards towards the mesial plane, where they meet, and where they are pierced by three canals, the rectum, the vagina, and the urethra. Owing to the inclination of the pelvis, the whole pelvic floor (but especially the posterior section) also slopes somewhat forwards (Fig. 113); therefore the fœtal head, when it reaches the pelvic floor, rests upon a sloping, not a horizontal, surface, the general direction of the slope being downwards, forwards, and inwards.

The effect of the changes which occur in the pelvic floor during the second stage is greatly to stretch and often to injure the anterior fibres of the levator ani muscle and the portion of the pelvic fascia to which it is attached. These fibres arise from the posterior surface of the symphysis pubis, and passing downwards and backwards ensheath the walls of the vagina. The great dilatation which the vaginal canal undergoes, and the extent to which its posterior wall becomes elongated, during the passage of the child through it, necessarily inflicts a certain amount of injury upon the muscular fibres, and in some instances upon the fascia also. This results later on in prolapse of the vaginal walls and of the uterus itself.

II. The Fœtus.—Under this heading we have to consider (1) the disposition of the fœtus *in utero*; (2) the size and characters of the fœtal skull; and (3) the protective action of the bag of fluid in which the fœtus is contained.

(1) *The Disposition of the Fœtus.*—During the last weeks of pregnancy the head, trunk, and limbs of the fœtus are packed up into the smallest possible space in a regular and fairly constant arrangement, which is termed the fœtal *attitude*. This is best described as an attitude of general flexion (Fig. 114), and the study of frozen sections has entirely removed this point from the field of speculation. The head is flexed so that the chin touches the anterior chest-wall; the forearms are flexed and crossed more or less symmetrically, so that forearms and hands cover the face (Fig. 114); the thighs are fully flexed on the abdomen, the legs on the thighs, the feet on the legs, the latter being generally crossed, but sometimes lying side by side; and lastly the spine is flexed, the back forming a distinctly con-

vex surface. Slight departures from this arrangement may be met with. Thus the forearms may lie under the chin as in Fig. 115, thus rendering complete flexion of the head

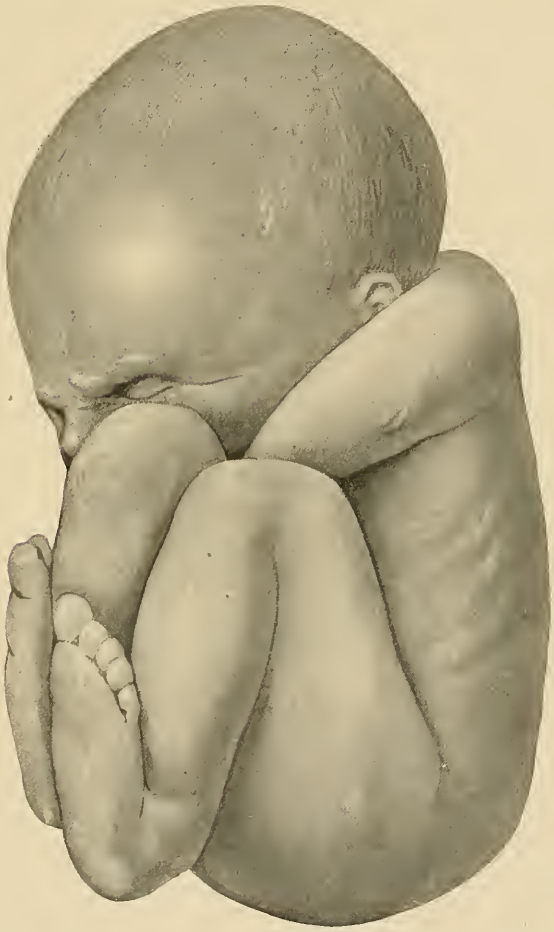


Fig. 115.—Fœtus showing Deficient Flexion of the Head through the Arms being underneath the Chin. (Barbour.)

impossible. All abnormalities of attitude lead to a certain amount of difficulty in labour. Any disturbance of this attitude usually involves some departure from the normal course of labour.

As thus disposed, the body of the fœtus forms an ovoid

mass the greatest width of which corresponds with the shoulders. The dimensions of the ovoid are as follows (Fig. 116):

Vertico-podalic diameter	(V-P)	.	$9\frac{1}{2}$ to 10 in. (24 to 25 cm.)
Bis-acromial ,,	(A-A)	.	$4\frac{3}{4}$,, (12 cm.)
Bi-trochanteric ,,	(T-T)	.	4 ,, (10 cm.)

The widest transverse diameter is across the shoulders. The smallest circumference of the flexed head is about 11 inches (27·5 cm.); the circumference of the breech, both thighs being flexed, is about 13 inches (32·5 cm.).

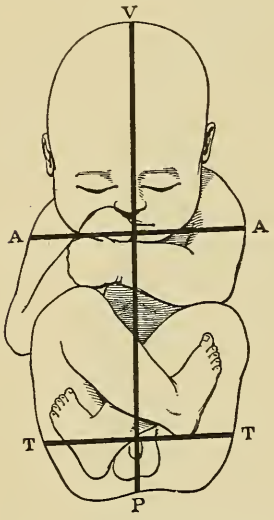


FIG. 116.—The Normal Attitude of Flexion (Diagrammatic). (Dakin.)

From this it follows that the fœtal ovoid will adapt itself most easily to the ovoid shape of the uterine cavity at term when the head lies below and the breech above; the least convenient arrangement will be that in which the fœtal ovoid lies across the uterine ovoid. When the long axes of the fœtal and uterine ovoids correspond, the arrangement is called the *longitudinal lie;* of this there are two varieties—(*a*) that in which the head is below, and (*b*) that in which the breech is below. When the long axes do not correspond, the arrangement is called the *transverse* or *oblique lie*. In over 96 per cent. of all labours the lie is longitudinal with the head below; when this is the case, the part of the head which first enters the pelvic brim is in the great majority of cases the *vertex*. This arrangement is called in brief a *vertex presentation*, the first part to enter the brim being always termed the *presenting part*. Presentation of the vertex implies that the head is fairly well flexed, even if the chin does not actually rest on the chest. If the head is imperfectly flexed some other part will present.

(2) *The Fœtal Skull.*—Since the head presents in such a

preponderating proportion of cases, it must be studied in detail and in relation to the parturient canal through which it has to pass.

The ossification of the fœtal skull at term is incomplete, especially in the case of the bones which compose the vault. While those of the base are firm and incompressible the tabular bones of the vault remain thin and pliable, and are separated at their edges by intervals of unossified membrane forming the *sutures* and the *fontanelles*. The vault of the skull is consequently compressible, and in fact it becomes

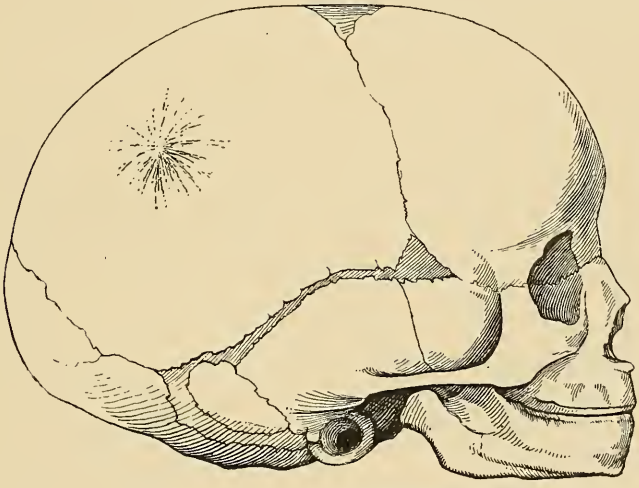


Fig. 117.—Side View of the Fœtal Skull.

modified considerably, both in size and shape, by the pressure to which it is subjected during labour.

The *sagittal* suture crosses the vault of the skull in the middle line, lying between the two parietal bones (Fig. 118, *b*); in the same plane in front of the anterior fontanelle runs the *frontal* suture, lying between the two halves of the frontal bone. The *coronal* suture separates the frontal from the parietal bones, meeting the sagittal and frontal sutures at the anterior fontanelle (Fig. 118, *b*). The *lambdoidal* suture separates the parietal bones from the tabular portion of the occipital bone (Fig. 118, *a*).

Four or five fontanelles exist in the skull at term, but only two of them are of practical importance in midwifery

—viz., the anterior and posterior fontanelles. The *anterior fontanelle* or *bregma* is an unequal-sided lozenge-shaped piece of unossified membrane, lying in the mesial plane between the two frontal and the two parietal bones (Fig. 118, *b*). Its angles are continuous with the frontal, the sagittal, and the right and left halves of the coronal sutures. The latter enter it considerably behind its centre. It measures $1\frac{1}{4}$ inches in antero-posterior and $\frac{4}{5}$ inch in transverse diameter, and as it lies a little below the general level of the skull, it can be felt on the surface as a shallow depression. The *posterior fontanelle* is not as a rule an unossified piece of membrane at all, but a triangular depres-

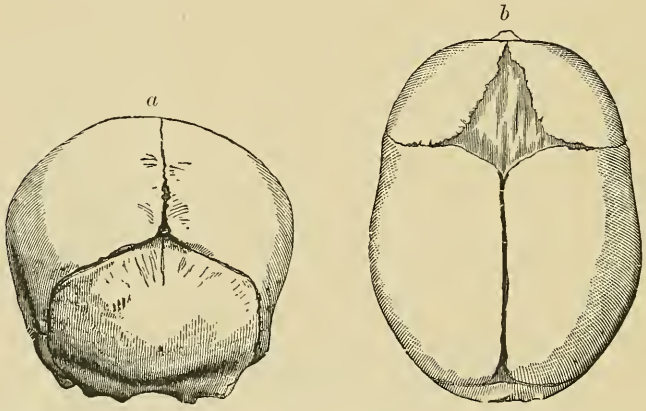


Fig. 118.—*a*, Fœtal Skull showing the Posterior Fontanelle. *b*, Fœtal Skull showing the Anterior Fontanelle. (Galabin.)

sion produced by the angle of the tabular portion of the occipital bone being slightly depressed below the level of the posterior borders of the parietal bones with which it comes in contact (Fig. 118, *a*). This depression lies at the point of junction of the sagittal suture with the right and left halves of the lambdoidal suture. In a premature fœtus, however, an unossified piece of membrane often persists at the posterior fontanelle.

These two fontanelles are of importance because they can be recognised by touch during labour, and from them valuable information can be obtained as to the position and attitude of the fœtal head. The anterior can be recognised by its lozenge shape, its soft membranous floor, and the

presence of four sutures running from its angles. The frontal may be distinguished from the sagittal end of this fontanelle by its greater width. The posterior is triangular in shape, has a hard floor, a raised edge (parietal), and is connected with only three sutures.

The general shape of the fœtal head is that of an ovoid with a long antero-posterior diameter (Fig. 117). In the normal attitude of complete flexion the long diameter of the head ovoid forms a very acute angle with that of the body ovoid; when the head lies midway between flexion and extension the two long diameters cross one another at right angles; when the head is fully extended the angle formed is very obtuse and the face becomes the lowest part. This part of the circumference of the head which first comes in contact with the pelvic brim—*i.e.*, the *girdle of contact*—varies with the degree of flexion or extension which may be present, and accordingly the diameter of the girdle of contact (*diameter of engagement*) also varies. In passing from the position of complete flexion to that of complete extension the diameters of the successive girdles of contact are as follows:

	Length.	Presentation.
1. Sub - occipito - bregmatic (S.-o.-b.) (nape of neck to centre of bregma)	$3\frac{3}{4}$ in. (9·50 cm.)	Completely flexed vertex
2. Sub - occipito - frontal (S.-o.-f.) (nape of neck to anterior end of bregma)	4 in. (10·00 cm.)	Incompletely flexed vertex
3. Occipito-frontal (O.-f.) (occip. protuberance to root of nose)	$4\frac{1}{2}$ in. (11·25 cm.)	Extended vertex
4. Mento - vertical (M.-v.) (point of chin to centre of sagittal suture)	$5\frac{1}{2}$ in. (13·75 cm.)	Brow presentation
5. Sub - mento - vertical (S.-m.-v.) (angle between neck and chin to centre of sagittal suture)	$4\frac{1}{2}$ in. (11·25 cm.)	Incompletely extended face
6. Sub - mento - bregmatic (S.-m.-b.) (angle between neck and chin to centre of bregma)	$3\frac{3}{4}$ in. (9·50 cm.)	Completely extended face

In addition to the above, three transverse diameters of

the head are of importance : (1) the *bi-parietal* ($3\frac{3}{4}$ inches—9·50 cm.), between the two parietal eminences ; (2) the *bi-temporal* ($3\frac{1}{4}$ inches—8 cm.), between the anterior ends of the coronal suture ; (3) the *bi-mastoid* (3 inches—7·5 cm.), between the tips of the mastoid processes. The circumference of the head varies in different planes ; the smallest circumference is that of the sub-occipito-bregmatic plane, which measures 11 inches.

It must be recollected that all diameters which involve the vault are compressible, and can be reduced in length to an appreciable extent during the passage of the head through the pelvis.

(3) *The Liquor Amnii.*—During the greater part of the process of labour the fœtus is protected from pressure by the liquor amnii at every part except the girdle of contact. The uterine contractions do not act directly upon the body of the fœtus until labour is far advanced and the liquor amnii has more or less completely escaped. The lower pole of the fœtal envelopes containing the fore-waters becomes detached from the lower uterine segment early in labour, and is driven down by the contractions into the cervix in advance of the presenting part of the fœtus. The mechanical value of this *bag of waters* as an aid to the dilatation of the cervix is very considerable, on account of its elasticity and its shape. When the cervix is dilated and the bag of waters is consequently unsupported, the membranes, as a rule, can no longer resist the strain of the increased tension produced by the uterine contractions, and rupture accordingly takes place. The membranes may, however, in some cases, rupture before labour or early in the first stage ; on the other hand, when unusually strong, spontaneous rupture may not take place at all, the bag of waters appearing at the vulva during the birth of the head.

In normal conditions the liquor amnii is sterile ; it may, however, become infected during labour by bacteria introduced from without, or by organisms which reach it through the placenta from the maternal circulation, as in certain acute infectious fevers. The former is, of course, greatly facilitated if ante-partum rupture of the membranes should occur, although we also know, from clinical observation, that bacterial infection may take place through intact membranes.

The liquor amnii may also be fouled by meconium passed *in utero* in conditions producing fœtal distress.

III. The Forces of Labour.—The propelling force consists of muscular contractions, aided possibly to an insignificant extent by gravity and by the elastic recoil of certain portions of the birth-canal. The most important muscle is the uterus; subsidiary to it are the diaphragm and the muscles of the abdominal wall; those of the arms, legs, and back lend a certain amount of assistance in the expulsive stages.

The Parturient Uterus.—The changes which the uterine muscle undergoes during pregnancy have been already described. At term the wall of the uterus is about $\frac{1}{3}$ inch in thickness, and the organ measures $11\frac{1}{2}$ to 12 inches (29 to 30 cm.) in length from os externum to fundus (cervix $1\frac{1}{4}$ to 2 inches—3·5 to 5 cm.); the diameters of the fundus itself are about 8 to 9 inches (20 to 22·5 cm.) transversely and 6 inches (15 cm.) antero-posteriorly. At the lower uterine segment the diameters are less, so that the organ is distinctly pyriform or ovoid in shape. The internal os is usually closed and the cervical canal intact when labour sets in (Fig. 97). The parturient uterus acts by intermittent contractions, which are limited to the upper three-fourths of the body, and which have the effect, first, of dilating the lower uterine segment and cervix, and secondly, of expelling the uterine contents. The organ thus becomes differentiated during labour into an upper active and a lower passive section; this is probably an essential step in the process of parturition, and invariably precedes the actual expulsion of the fœtus.

The uterine contractions of labour are to be regarded as a development of the slight intermittent contractions which can be recognised clinically in the gravid uterus during the second half of pregnancy. During pregnancy the patient is unconscious of their presence, and they produce no effect upon either the cervix or the ovum; when labour begins they change their characters and become painful. Throughout the process they preserve their intermittent character, but the intervals tend gradually to diminish as labour advances, until the actual expulsion of the child through the vulva may be accomplished by a storm of powerful con-

tractions separated by only slight intervals. After this their intensity suddenly falls, and the last part of the process—viz., the separation and expulsion of the after-birth—is accompanied only by a few comparatively feeble contractions. They are of course involuntary ; in animals they are peristaltic, but clinically this is not observable in women. It may be surmised that the driving force of the uterus resides chiefly in the longitudinal fibres, contraction of which will tend to approximate fundus to cervix.

With each contraction a change in the shape and position of the uterus occurs. When at rest the organ lies moulded upon the vertebral column (Fig. 46) ; during the contraction the fundus is thrown forward towards the abdominal wall, and the whole organ becomes rigid and erect. The effect of this change of position will be to make the long axis of the uterus correspond more closely with the line of the axis of the pelvic brim (Fig. 100).

As labour advances two other important changes are brought about in the parturient uterus—viz., (1) *dilatation* of the lower uterine segment and cervix ; (2) *retraction* of the uterine wall above this level. The exact nature of these changes has been the subject of acute controversy since the study of the anatomy of labour by frozen sections began, and even now unanimity of opinion has not been reached. In the following description the work of Barbour has been followed.

(1) *Lower Uterine Segment and Cervix.*—The condition of the cervical canal before labour commences has been already described ; it measures from $1\frac{1}{4}$ to 2 inches (3 to 5 cm.) from os externum to os internum, and the lower uterine segment, corresponding to about the lower one-fourth of the total uterine cavity (Barbour), has the shape of a hemisphere.

The condition of these parts at the end of the second stage of labour is shown in Fig. 119. The lower segment has now been converted from a hemisphere into a cylinder, and forms with the dilated cervix a single wide canal. The position of the os internum is very difficult to determine except by recognition of the upper limit of the characteristic cervical mucous membrane. But the conclusions arrived at by different observers upon this point are very divergent,

and it appears probable that the proportion of the dilated part which corresponds to the cervix is variable. At the upper limit of this dilated part an abrupt change in the thickness of the uterine wall takes place, producing a raised ridge on the inner wall in the form of an irregular ring which varies a little in level in different parts. This ring is variously known as the *retraction ring* (Barbour), the *con-*

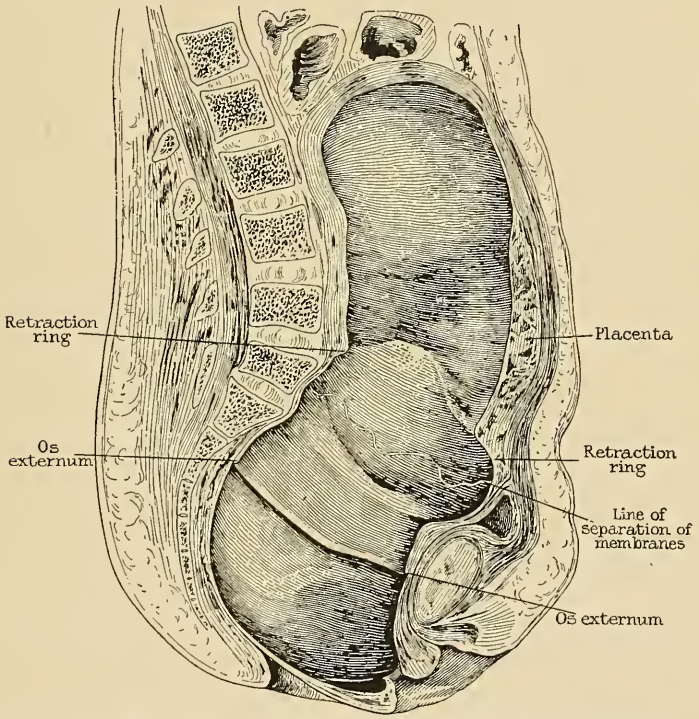


Fig. 119.—The Birth-Canal towards the end of the Second Stage of Normal Labour. (Barbour.)

traction ring (Schroeder), *Bandl's ring*, *Barnes's ring*, &c. By some observers this ring was regarded as representing the internal os, the whole of the dilated part below it was considered to be cervix, and the existence of a lower uterine segment, distinct from the cervix, was denied. The work of Schroeder, Barbour, and Von Franqué, however, appeared until recently to have satisfied most observers that the upper portion of the dilated part comes from the uterine body, not

from the cervix. But this view has now again been challenged by Bumm and Blumreich, so that it is evident that controversy upon this matter is not yet over.

The wall of the lower segment and cervix measures on an average one-tenth of an inch (25 mm.) in thickness, while above the lower segment the uterine wall varies from one-half to a-quarter of an inch (1·25 to 0·62 cm.) in thickness, being least at the placental site. Lower segment and cervix together now measure in length $3\frac{1}{2}$ inches (9 cm.) on the anterior and $2\frac{1}{2}$ inches (6·5 cm.) on the posterior wall. From examination of a number of frozen sections it appears that the average length of the uterus from fundus to os externum is 10 to $10\frac{1}{2}$ inches (25 to 26 cm.) towards the end of the second stage of labour—*i.e.*, before the explusion of the fœtus. The total length of the uterus has therefore at this period been reduced by about $1\frac{1}{2}$ inch (4 cm.). The diameter of both lower segment and cervix is now about 4 inches (10 cm.). The *posterior vaginal wall* is greatly elongated—7 inches (18 cm.) in Fig. 119—and somewhat thinned, while the anterior wall is practically unaltered in length.

(2) *The Retracting Uterine Wall.*—The line of abrupt transition from the lower segment to the uterine body above it represents the line of physiological differentiation of the uterus into an upper active and a lower passive zone. The uterine contractions occur in the active portion only, the *rôle* of the other being entirely passive, as is shown by the marked degree of dilatation and thinning which it has undergone. The reduction in length of the active portion and the increased thickness of its walls represent, however, another phase of its activity—viz., *retraction*. The distinction between contraction and retraction of muscle is simple : contraction is a temporary reduction in length of the muscle, which may be succeeded by complete elongation to its original length ; but retraction signifies permanent shortening, complete elongation being impossible so long as the retraction lasts. In the case of a muscle contracting intermittently, a certain amount of retraction may accompany each contraction, unless, when the contraction passes off, it is again elongated to the full extent. Shortening from retraction will thus become progressive. This is what occurs in the uterus during the second stage of labour : as

the fœtus is driven with each contraction lower down into the pelvis, a certain amount of the advance is made good by retraction. If retraction did not occur, then the elastic recoil of the soft structures composing the walls of the undilated parts of the canal would act through the lower pole of the ovum upon the uterine muscle and completely elongate it, so that the fœtus would return to the position it occupied before the contraction occurred. Advance under such circumstances would of course be much delayed. Retraction, therefore, maintains a certain amount of the progress made during each contraction. It will also be noticed that retraction must cause some diminution in the superficial area of the uterine wall ; this is of importance in regard to the mechanism of separation of the after-birth. In cases of obstructed labour retraction becomes greatly exaggerated, so that the retraction ring forms a ridge which can be recognised by palpation through the abdominal walls (see p. 463). In cases of unobstructed labour its presence cannot be recognised by clinical observation.

Dilatation of the lower segment and cervix is brought about by the uterine contractions acting either through the bag of waters or directly through the presenting part. The conical shape and elastic consistence of the bag will enable it to dilate the canal equally, acting as a ' fluid wedge.' The presenting part forms a much less efficient dilator, partly because it is inelastic, partly because it does not adapt itself so readily in shape to the dilating canal. A certain relationship normally exists between active contractions of the body of the uterus and dilatation of the cervix ; whenever active contractions occur the cervix at once begins to open ; and, conversely, if the cervix is artificially dilated, active contractions will be induced in the body of the uterus. This physiological relationship has been termed the *polarity* of the uterus. It has also been suggested that the longitudinal fibres of the outer muscular wall, when contracting, tend to pull the cervix upwards over the presenting part, and thus to some extent assist the process of dilatation.

Anything interfering with the normal mechanism, such as inefficient contractions, premature rupture of the membranes, or structural alterations in the cervix, will prevent or delay the occurrence of dilatation.

The Labour Centre.—It is possible that the process of parturition is under the control of a special centre in the lumbar enlargement of the spinal cord, for it is well known that in certain animals powerful uterine contractions can be induced by experimental stimulation of the lumbar enlargement. Also, women suffering from paraplegia due to injury or disease affecting the cord above the level of the lumbar enlargement, may pass through an easy and rapid labour, which is, of course, painless. These facts, however, do not suffice to prove the existence of a labour centre ; for large sympathetic ganglia are found at the sides of the uterus, between the layers of the broad ligament, which may, by automatic action, themselves induce contractions. Certainly in some animals rhythmic contractions of the uterine muscle may be induced by stimulating these ganglia, or the uterus may be made to contract after its removal from the body in the same manner. In the human subject, however, the balance of probability is in favour of the existence of a centre in the cord.

The manner in which the nerve centres, whether peripheral or spinal, are so excited as to initiate the process of labour is unknown. The onset of labour is no doubt due in some way to stimulation of these centres, and although many hypotheses have been advanced, the fact remains that there is little or no evidence in favour of any of them, and accordingly they need not be discussed. The progressive increase in the activity of these centres when once labour has commenced may be simply explained by peripheral stimuli coming from the uterine nerves, which are stretched by dilatation or compressed by muscular contraction.

General Effects of Labour.—During a uterine contraction it is noticed that the fœtal heart beats more slowly and more feebly, but quickly recovers its normal action as the pain passes off. The uterine souffle becomes louder at the commencement of a contraction, then rapidly diminishes, and becomes quite inaudible at the acme of the contraction. The mother's pulse is quickened during the contractions. The amount of blood lost during normal labour averages about 10 ounces, more than half of which accompanies the placenta. In women of average physique, the general effects of normal labour are usually those of physical exhaus-

tion, corresponding with the length and severity of the labour pains. The temperature may be elevated one or two degrees and the pulse a little accelerated—ten to fifteen beats above the normal. In women of less than average physique, normal labour sometimes leads to alarming *surgical shock*, accompanied by pallor, coldness of the body surface, especially of the limbs, rapid and feeble pulse, and a subnormal temperature ; sometimes there is loss of consciousness. There may be no unusual hæmorrhage in such cases. Treatment by the application of heat to the body, the rectal injection of warm saline solution, and the deep intramuscular injection of pituitrin is usually successful. The author has, however, seen two cases in which the symptoms were so alarming that intra-venous saline transfusion was resorted to. A certain number of cases which terminated fatally have been recorded.

Acute dilatation of the heart sometimes occurs after labour in persons not previously known to suffer from heart lesions. In all probability some cardiac defect has passed unobserved in such cases. A trace of albumen is frequently found in the urine of perfectly healthy women during normal labour ; this is especially common in primiparæ.

Anatomy and Physiology of the Third Stage of Labour

It has now been demonstrated by the study of frozen sections that separation of the placenta and the greater part of the membranes does not occur until the third stage (see Fig. 119). At the beginning of this stage the uterus measures about 8 inches (20 cm.) vertically and 4 inches (10 cm.) antero-posteriorly ; its wall is greatly thickened at all parts except the placental site. The uterine cavity is so reduced that the placenta practically fills it. The membranes are still attached to the uterine wall except in the lower segment, from which they become detached during the stage of dilatation, while the placenta is folded and much reduced in size. The plane of cleavage runs through the cavernous layer of the decidua basalis (Fig. 17), the deepest part of which remains attached to the uterine wall.

It is, however, quite clear that in the great majority of

cases the placenta is delivered in one of the following two ways : (1) In some instances a portion of the placenta near its centre becomes separated, and hæmorrhage from the torn uterine sinuses occurs at that spot. As more blood is effused, an increase in the area of separation occurs by the formation of a retro-placental blood clot. The centre of the placenta is thus forced down towards the cervix, where its fœtal surface,

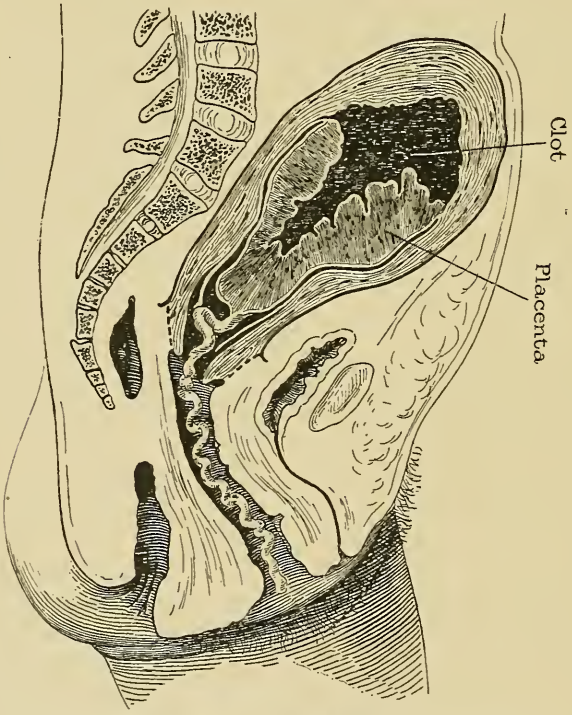


Fig. 120.—Separation of the Placenta by formation of Retro-placental Clot. Diagrammatic. (Varnier.)

with the umbilical cord attached, presents ; it then passes through the aperture in the membranes formed by the passage of the fœtus, and enters the vagina, pulling the membranes off behind it and turning them inside out. This mode of separation, which can frequently be observed, was first described by Schultze. It is diagrammatically represented in Fig. 120, and is shown *ad naturam* in Fig. 121, in a uterus removed from the body after death. (2) The second

mode of separation of the placenta is illustrated in Figs. 122 and 123, and was first clearly described by Matthews Duncan. Detachment commences at the lower pole, which is not subjected to the same amount of compression as the remainder of the placenta, on account of the patulous condition of the cervical canal, and the whole organ is gradually forced into the cervix, the upper pole being the last to leave the uterine cavity. The edge or the uterine surface of the placenta presents in this case.

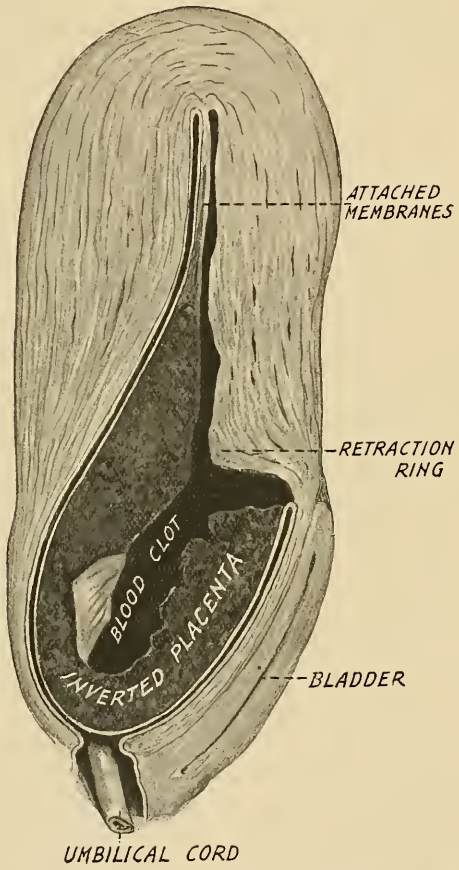


FIG. 121.—Uterus in the Third Stage. The placenta is inverted and detached, lying in the lower segment. It is held up by adhesion of the membranes to the fundus. A small retro-placental clot has been formed. (Barbour's Anatomy of Labour.)

The mechanism of the latter mode of separation has been explained by Barbour as follows: When retraction occurs after the expulsion of the child, the area of the uterine surface is much diminished; the placenta, being an inelastic organ, cannot follow this diminution to any great extent, and therefore becomes detached, the uterine wall tearing itself away from the placenta. This process begins at the lower pole,

because there the edge is entirely unsupported. Separation, thus commenced, is advanced by each recurring contraction, and hæmorrhage plays no part in this mechanism. In the case of the first-mentioned mode of separation, on the other hand, relaxation of the uterus at the placental site, leading to effusion of blood, is probably the initial factor in its pro-

Fig. 122.—Separation of the Placenta from below upwards. Diagrammatic. (Bumm.)

duction ; this mode of separation will therefore be met with when retraction in the third stage is inadequate. It has been suggested that in cases of fundal insertion of the placenta, the same result may occur without hæmorrhage ; the central portion of the placenta, being then unsupported, becomes first detached by retraction and then driven downwards by contractions, thus causing the fœtal surface to present in the cervix.

The separated placenta is expelled through the cervix, vagina, and vulva mainly by the action of the accessory

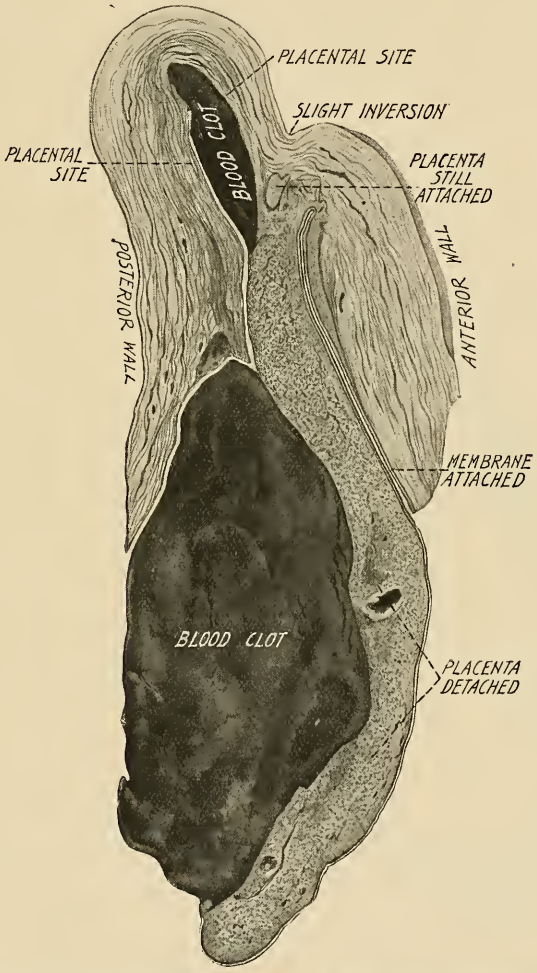


Fig. 123.—Uterus in the Third Stage. The placenta presents by its edge, and is adherent at one point to the uterine wall producing a partial inversion. An enormous retro-placental clot has been formed which was the cause of death. (Barbour's Anatomy of Labour.)

muscles ; uterine contractions are at this stage too feeble to play any important part in the process of expulsion.

From statistics of the Rotunda Hospital, Dublin, it

appears that the placenta separates by the Schultze method much more commonly than by the other, the proportions being about 83 to 17 per cent. It also appears that the former mechanism is the more favourable, for the membranes were found to be incomplete three times more often with the Matthews Duncan than with the Schultze mechanism.

The Mechanism of Normal Labour

In this section will be described the effects produced by the expulsive forces upon the ovum, and the manner in which the process of expulsion is accomplished.

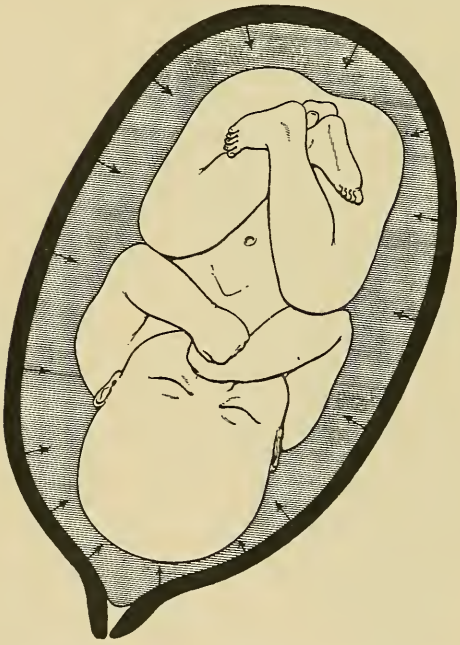


Fig. 124.—General or Indirect Intra-uterine Pressure. (Dakin.)

The arrows indicate the direction of the force exerted by the contracting uterus.

First and Second Stages.—It will be understood that during the greater part of the process of labour the uterine contractions do not act directly upon the body of the fœtus, for the latter is completely protected by the amniotic fluid. Pressure is transmitted to the fœtus only through this fluid covering, and since pressure is transmitted by a fluid medium equally in all directions, the effect must be mainly of the nature of general compression by increase of intra-uterine tension (*general or indirect intra-uterine pressure*) (Fig. 124). In this way an expulsive action will, however, be exerted upon the complete ovum (membranes unruptured), causing it to protrude through the dilating cervix, and in some cases

an unruptured ovum may be thus completely expelled from the uterus ; but here the expulsive forces never act directly upon the body of the fœtus at all. While the membranes remain intact, or when sufficient liquor amnii is retained, it follows that no effects injurious to the fœtus can be produced. The direction of the advance at this stage must be that of least resistance—viz., through the expanding cervix. This direction will be represented by a line drawn at right-angles to the plane of the internal os—the *axis of the internal os*. When the uterus is made erect by contraction, and there is only slight lateral obliquity, the axis of the uterus and the axis of the internal os are practically identical, and correspond with the axis of the pelvic brim.

When the membranes have ruptured and the greater part of the liquor amnii has escaped—*i.e.*, towards the end of the second stage of labour—the contracting uterine wall comes down upon the body of the fœtus, exerting pressure directly upon it (*direct intra-uterine pressure*) (Fig. 125). The driving force now acts upon the breech, and the line of advance will be the line of the fœtal axis ; this corresponds under normal conditions to the axis of the pelvic inlet. The term *fœtal-axis-pressure* is often applied to the uterine force at this stage. Force thus exerted upon the trunk of the fœtus, when the head is in the pelvic cavity, will cause the head to advance in the direction of that part of the pelvic axis to which it corresponds at the time. It will be clear that prolonged pressure in these circumstances may produce injurious effects through direct compression of the body of the fœtus, the placenta, or the cord.

Fig. 125.—Direct Intra-uterine, or Fœtal-Axis-Pressure. (Dakin.)

In normal labour the progress of the fœtus through the

birth-canal is watched by observing the advance of the fœtal head ; the relation of the head to the pelvic brim at the commencement of labour is therefore of great importance. It has already been stated that the vertex presents in 96 per per cent. of all labours. This predominant frequency is due to two causes : (1) under normal conditions the fœtal ovoid adapts itself best to the shape of the uterus when the head lies below, the breech above ; (2) the centre of gravity of the

Fig. 126.—Vertex Presentation. First Position (L.O.A.).
(Farabœuf and Varnier.)

fœtus lies nearer the head than the breech, therefore the fœtus will, if undisturbed, float in the liquor amnii with the head below.

With the vertex presenting, the fœtus may occupy four different *positions :* the back may be anterior and directed either to the left or right of the mother ; or the back may be posterior and directed either to the right or left of the mother. The part of the vertex which corresponds with and indicates the position of the back is, of course, the occiput ; this is termed the *denominator* of the positions which are named from it thus (Figs. 126 to 129) :

1st position	Left occipito-anterior	L.O.A.
2nd ,,	Right occipito-anterior	R.O.A.
3rd ,,	Right occipito-posterior	R.O.P.
4th ,,	Left occipito-posterior	L.O.P.

The term *position* thus indicates the relation of the back of the fœtus to the mother, and it will be found that in all kinds of presentation the four positions correspond. In the first and third positions the diameter of engagement of the head roughly corresponds with the right oblique diameter of the

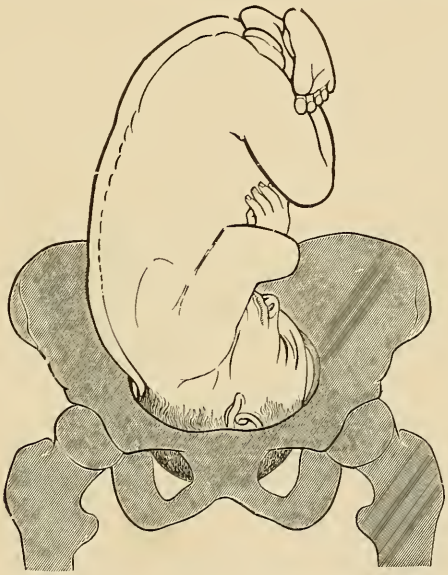


Fig. 127.—Vertex Presentation. Second Position (R.O.A.). (Farabœuf and Varnier.)

pelvic brim ; in the second and fourth positions it corresponds with the left oblique.

The frequency of the various *positions* of the vertex in earlier editions of this work was stated as follows :

1st position	74%	Right oblique diameter	94%
2nd ,,	5%		
3rd ,,	20%		
4th ,,	1%	Left ,, ,,	6%

The annual reports issued by Queen Charlotte's Lying-in Hospital contain statistics of position observed in the large

number of cases delivered at that institution, and these statistics give quite different results. Calculated from a series of 10,000 consecutive cases the percentages of frequency are as follows :

1st position .	. 53·1%	Right oblique diameter	. 67·1%
2nd ,, .	. 21·4%		
3rd ,, .	. 14·0%		
4th ,, .	. 11·5%	Left ,, ,,	. 32·9%

The reports show a remarkable similarity in the proportions

Fig. 128.—Vertex Presentation. Third Position (R.O.P.). (Farabœuf and Varnier.)

met with in each year, and these figures may probably be considered more accurate than the older statistics which were given on the authority of Nägele. Although differences of opinion as to the exact proportions may be held, it is now generally agreed that the first is the most frequent and the fourth the rarest ; the second and third being more nearly equal in frequency.

From this it will be seen that the vertex engages in the right oblique diameter much oftener than in the left ; this is mainly due to the fact that the left oblique is encroached upon by the presence of the sigmoid flexure and rectum, and

therefore does not accommodate the head so well as its fellow. Again, the first position is three to four times more frequent than the third ; this is to be accounted for by the fact that the fœtus lies more easily in the uterus when the back is anterior than when it is posterior. In the latter the convexity of the fœtal spine is opposed to the convexity of the maternal lumbar vertebræ, while in the former the ventral aspect of the fœtus adapts itself easily to the curve of the spinal column. In the fourth position, the rarest, the

Fig. 129.—Vertex Presentation. Fourth Position (L.O.P.). (Farabœuf and Varnier.)

conditions are the least favourable—viz., engagement in the left oblique diameter, and posterior position of the back. As we shall see, the posterior position of the back is also apt to cause some disturbance of the normal fœtal attitude of flexion.

The study of frozen sections has proved that when the vertex engages in the pelvic brim, owing to the lateral inclination of the head and to other causes, one parietal bone frequently lies at a lower level than the other ; as a result the sagittal suture does not correspond precisely to the oblique diameter, but lies either in front of or behind it. This is known as *asynclitism or parietal obliquity*. Usually

the head inclines to the posterior shoulder, the anterior parietal bone is below the posterior, and the sagittal suture nearer the promontory than the symphysis (*anterior asynclitism, anterior parietal obliquity*) ; sometimes, however, the sagittal suture lies nearer the symphysis than the promontory (*posterior asynclitism, posterior parietal obliquity*). The former is found chiefly in multiparæ, the latter in primiparæ, the reason being that in primiparæ the relatively tense abdominal walls tend to keep the uterus back and so prevent the body of the fœtus from coming forward into the line of the axis of the brim ; accordingly, when the head enters the brim the posterior parietal bone is lower than the anterior (Fig. 130, (*a*) and (*b*)). Sectional anatomy has shown that in some cases (about 25 per cent.) this lateral inclination is absent, and the sagittal suture corresponds to the oblique diameter of the pelvis. It is probable that under normal conditions asynclitism is corrected very early in labour.

The relation of the head to the pelvis at the onset of labour in the four positions of the vertex as it appears when viewed through the outlet is shown in Figs. 131 to 134. It will be seen that the sagittal suture roughly corresponds to one of the oblique diameters, but may lie a little in front or behind it as asynclitism is more or less pronounced. At one end of the suture lies the anterior fontanelle, at the other end the posterior fontanelle. If the head is well flexed, the posterior fontanelle is lower than the anterior ; if the head is imperfectly flexed, this will not be the case. These points will again arise in connection with the diagnosis of position.

In passing through the pelvis, the fœtus, in addition to following the curved line of the pelvic axis, describes a certain definite series of movements which alter its relations to the pelvic canal. The valuable information obtained in recent years by the study of frozen sections of women who have died in labour has made it necessary to modify certain of the older views regarding the nature and causation of these movements. It is customary to describe them as movements of the head, but in reality the head is only the index ; external rotation is essentially a movement of the trunk, and it is probable, as we shall see, that the same is also true of flexion and extension.

It will, of course, be understood that throughout the first

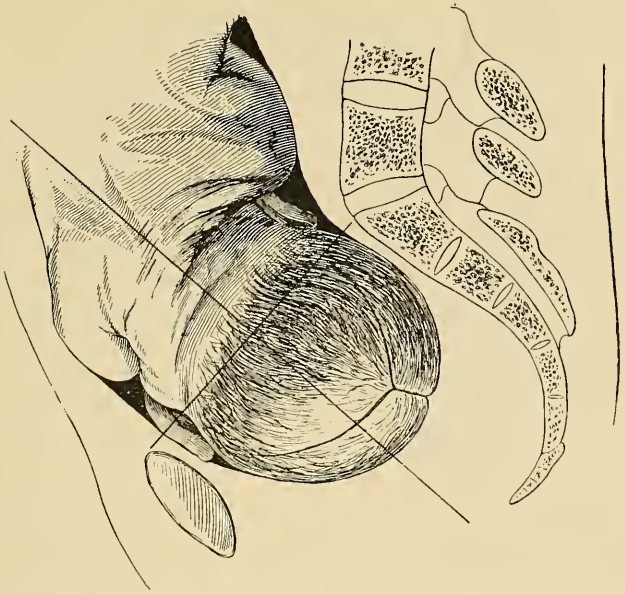


FIG. 130 (*a*).—Anterior Asynclitism; Nägele's Obliquity. (Bumm.)
The trunk lies away from the maternal spine.

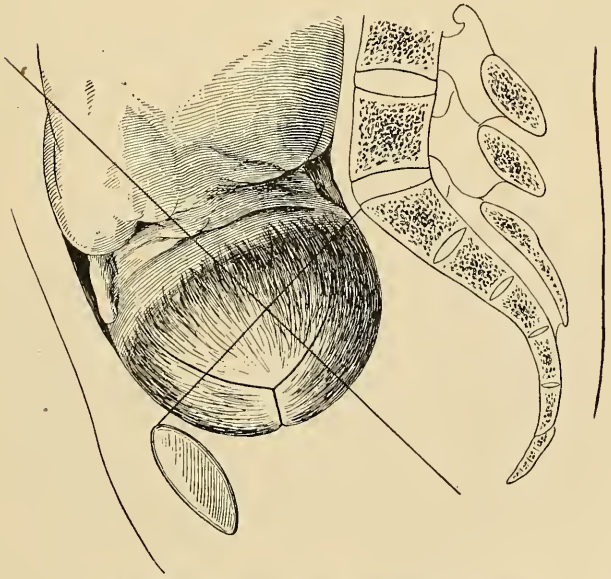


FIG. 130 (*b*).—Posterior Asynclitism. (Bumm.)
The trunk lies close to the maternal spine.

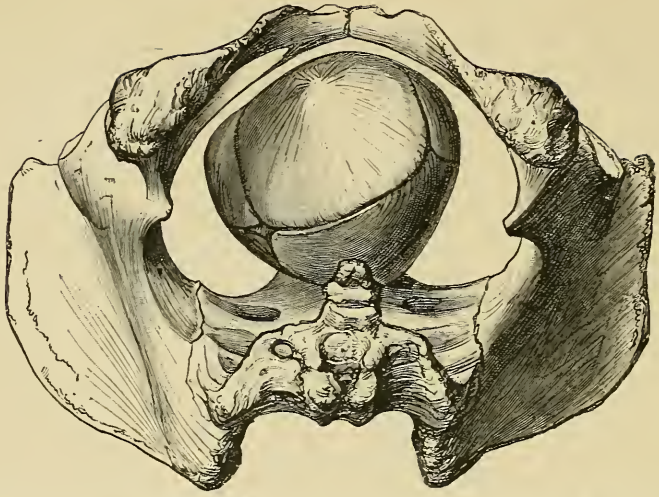


FIG. 131.—First Position of the Vertex (L.O.A.), Anterior Asynclitism.

and second stages of labour there is a more or less continuous movement of *descent*. Accompanying this, four other movements are described—viz. : (I.) *Flexion ;* (II.) *Internal Rotation ;* (III.) *Extension ;* (IV.) *Restitution and External Rotation.*

I. *Flexion.*—Sectional anatomy has shown that under normal conditions the head, as a rule, is flexed before labour

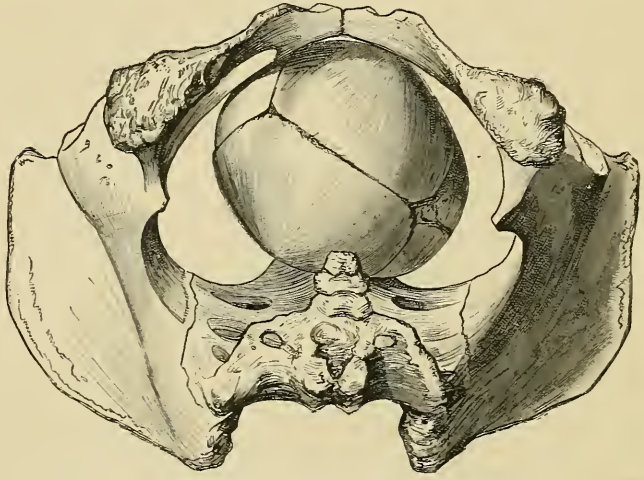


FIG. 132.—Second Position of the Vertex (R.O.A.).

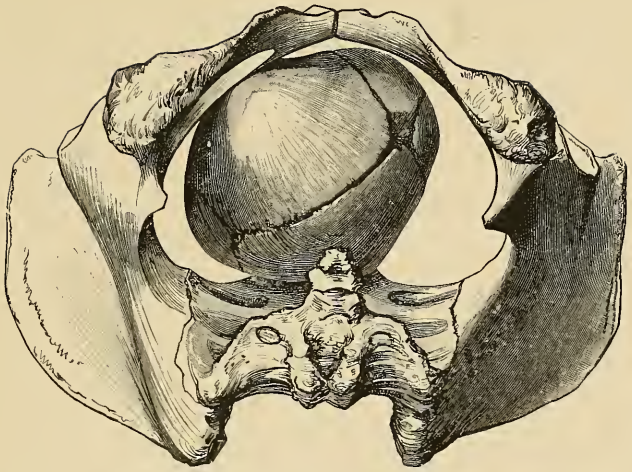


Fig. 133.—Third Position of the Vertex (R.O.P.). Head fairly well flexed.

begins. The degree of flexion is, however, subject to a slight variation, even under normal conditions ; when fully flexed the chin is in contact with the chest, but this may be modified by an unusually high position of the arms (Fig. 115), or by other causes. Flexion therefore is an *attitude*, not a *movement*, and the old view that it was normally produced during labour must be abandoned. Disturbances of the

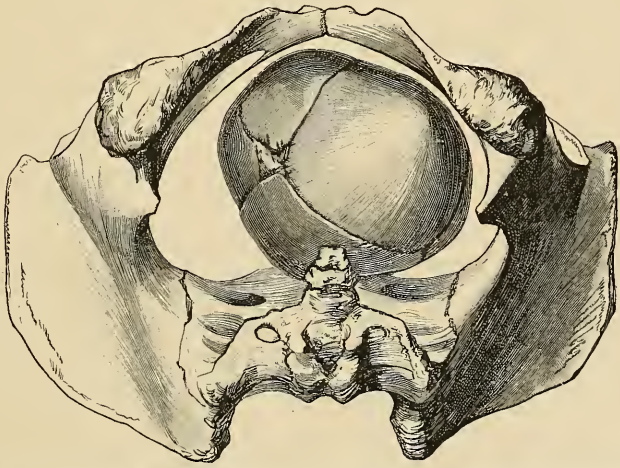


Fig. 134.—Fourth Position of the Vertex (L.O.P.), Anterior Asynclitism. Incomplete Flexion.

normal fœtal attitude of flexion at the onset of labour are, however, not uncommon, causing the head to enter the brim in an attitude of deficient flexion or of extension. During its passage through the pelvis it may then become flexed, and the mechanism of the process may therefore be briefly referred to, but it must be understood that such explanations are superfluous when the attitude of the fœtus before labour is normal. The conventional explanations of the movement of flexion are :

(a) *The Wedge Theory.*—When the fœtal head is looked at from the side it will be observed that this outline forms a wedge with unequal sides ; the apex of the wedge is near the posterior end of the sagittal suture, and the posterior side is steeper than the anterior (Fig. 135). In a vertex presentation, when the head is incompletely flexed, the steep posterior side of the wedge will meet with less resistance from contact with the passages than the anterior—*i.e.*, the occiput will advance more quickly than the sinciput, and the head will thus tend to move upon the occipito-atloid articulation into the attitude of flexion. This effect will be increased by the elastic pressure exercised by the resisting girdle of contact, for this pressure is applied to the front and back of the head at slightly different levels, thus forming a *couple of forces*, the tendency of which must be to rotate the head still further upon its transverse axis so as to bring the occiput lower than the sinciput (Figs. 136 and 137). These effects will be produced at all periods of the first and second stages whether the membranes are ruptured or not.

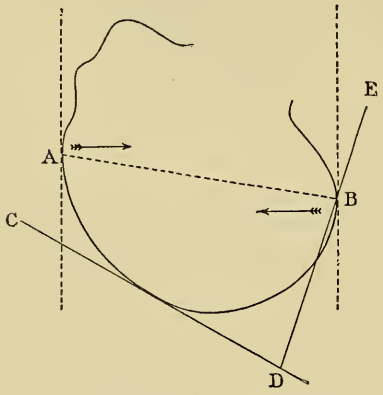


FIG. 135.—Effect of the Wedge Shape of the Head in producing Flexion. (Modified from Galabin.)

A, B. Diameter of engagement. C, D. Slope of anterior side of lateral wedge. E, D. Slope of posterior side of lateral wedge. The arrows indicate the effect of the elastic pressure of the girdle of contact.

(b) *Obliquity of the Uterus.*—It has been mentioned that

the gravid uterus at term is normally inclined a little to one or other side of the middle line, usually to the right. From this it has been argued that force transmitted in the uterine axis will be directed obliquely to the side *opposite* to that to which the uterus is inclined. Therefore, with right uterine obliquity, when the occiput lies to the left, the greater force applied to the posterior end of the head will promote flexion by causing the head to move upon the occipito-atloid

Fig. 136.—Vertex Presentation. First Position. The head is incompletely flexed, the diameter of engagement being approximately the occipito-frontal; pelvis divided in right oblique diameter. (Farabœuf and Varnier.)

articulation. If the obliquity of the uterus should be left instead of right, then extension would be promoted instead of flexion, the uterine force acting more powerfully upon the sinciput. It is probable, however, that little importance can be attached to this mechanism under normal conditions, for when the uterus contracts it tends to become erect, thus diminishing its lateral obliquity; the position it occupies when at rest can have no effect upon the advance of the head.

It must be recollected that when flexion is deficient the diameter of engagement is longer than when it is complete

(Figs. 136 and 137), and the difficulties attending the passage of the head are consequently greater. When the head is flexed to the greatest possible extent, the sub-occipito-bregmatic diameter engages. The shape of the head in the plane of this diameter is shown in Fig. 138, *a* ; its dimensions are well within those of the pelvic brim or cavity. When the head is less fully flexed the sub-occipito-frontal diameter becomes engaged ; the shape and size of the plane of this diameter are shown in Fig. 138, *b*. This plane is approxi-

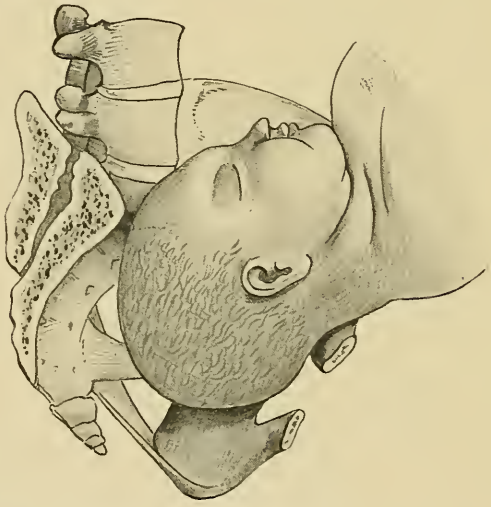


Fig. 137.—Vertex Presentation. First Position. The head is completely flexed, the diameter of engagement being the sub-occipito-bregmatic. (Farabœuf and Varnier.)

mately quadrilateral, and is therefore not so well adapted to pass easily through the pelvis, while its dimensions are of course greater than those of the sub-occipito-bregmatic plane. When the head is midway between complete flexion and complete extension, the occipito-frontal diameter engages, and the plane of this diameter has the same shape, but is of even larger size than the sub-occipito-frontal (Fig. 139). It will therefore be apparent that complete flexion of the head is of great mechanical advantage in a vertex presentation, since in this position the plane of engagement is not only the smallest possible, but also of a

shape which will readily pass through the pelvic canal. It is, however, probable that at the beginning of labour the head usually engages in the sub-occipito-frontal plane, or in a plane intermediate between this and the sub-occipito-bregmatic, and if the dimensions of the head and the pelvis

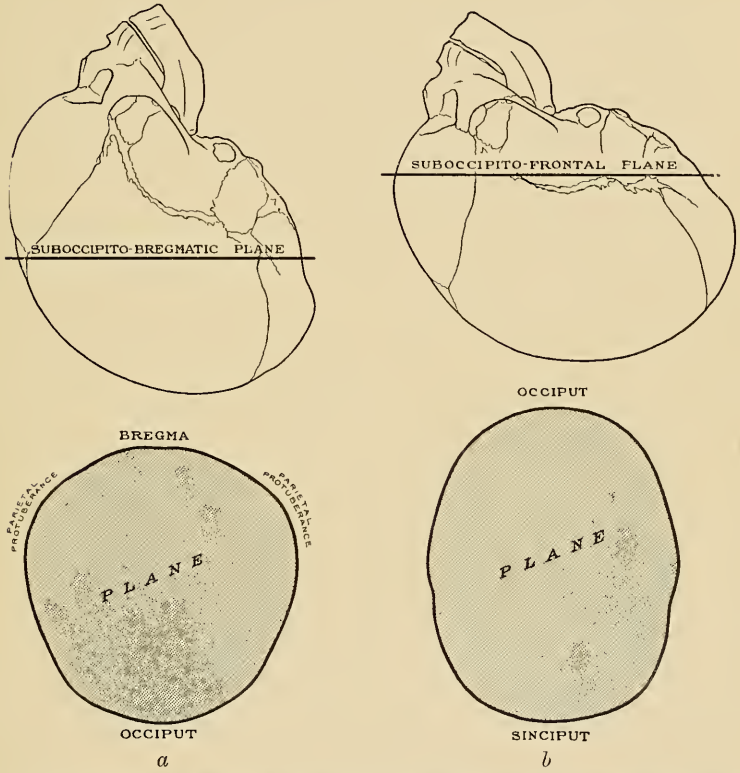


FIG. 138.—*a*, The Position and Shape of the Sub-Occipito-Bregmatic Plane of the Fœtal Head. *b*, The Position and Shape of the Sub-Occipito-Frontal Plane of the Fœtal Head. (Edgar.)

are normal, it may pass through without any marked increase of flexion being produced.

II. *Internal Rotation.*—The head enters the pelvic brim, as we have seen, approximately in the oblique diameter ; internal rotation is a movement which carries the head into the antero-posterior diameter of the pelvic outlet. The advantage gained by this movement is that the diameter of

engagement is brought into the longest diameter of the pelvic outlet, for when the coccyx is extended the antero-posterior measures about $5\frac{1}{4}$ inches. In the first and second positions internal rotation almost always brings the occiput forwards under the pubic arch ; in the third and fourth positions the same thing usually occurs ; but sometimes, from causes which will be mentioned later, the occiput rotates backwards into the sacral hollow while the sinciput comes to the front. In the first and fourth positions the direction of forward rotation is from left to right ; in the second and third from right to left.

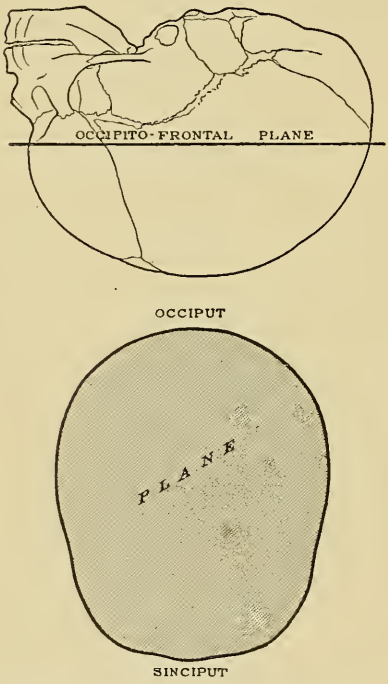


Fig. 139.—The Position and Shape of the Occipito-Frontal Plane. (Edgar.)

Forward Rotation of the Occiput.—The essential cause of this movement is the influence of the *sloping pelvic floor*. As we have seen, the soft parts forming the pelvic floor slope from behind forwards and downwards, and from the sides, forwards, downwards, and inwards — towards the middle line. Therefore a body coming in contact with any part of the pelvic floor will be directed by it forwards and downwards under the pubic arch. When the head is flexed the posterior part of the vertex reaches the pelvic floor in advance of the anterior (Fig. 137), and is accordingly directed forwards by its slope ; in other words, the occiput rotates under the pubic arch. This will occur whether the occiput lies in an anterior or a posterior position. Since the pelvic floor is deficient anteriorly in relation to the wide pubic arch, the part of the head which moves forward is moving in the direction of least resistance, and there is nothing to

oppose it. The movement of forward rotation is much longer in the case of posterior than anterior positions of the vertex, the difference being represented by about a quarter of a circle.

Braune's section of a woman who died during the second stage (Fig. 100) shows the movement of internal rotation in progress, the occiput coming forwards, while dilatation of the vulva has begun.

Backward Rotation of the Occiput.—If, in an occipito-posterior position, the head is extended so as to bring the occipito-frontal diameter into the pelvic brim, the anterior end of the vertex will form its lowest part. When this part reaches the pelvic floor it will be directed downwards and forwards under the pubic arch, and the occiput will consequently pass backwards into the sacral hollow. The primary cause of backward rotation is therefore extension of the vertex. While it is extremely rare in anterior positions, extension is not uncommon in posterior positions, and is amply accounted for by two considerations: (1) In posterior positions the general attitude of flexion is disturbed by some degree of extension of the spine which results from the opposition of the two convexities of the fœtal back and the maternal lumbar vertebræ; if the fœtal spine becomes extended the fœtal head will become extended also. This implies that some degree of extension is present at the commencement of labour. (2) Extension may be produced or increased during labour by the unfavourable position in which the head is placed (Fig. 140). The widest part of the fœtal head lies behind its centre and corresponds to the bi-parietal diameter. In a posterior position this diameter lies behind the oblique diameter of the brim, between the sacral promontory and the ilio-pectineal eminence—a position where space is limited, and it therefore meets with opposition to its descent. The narrow sincipital end, on the

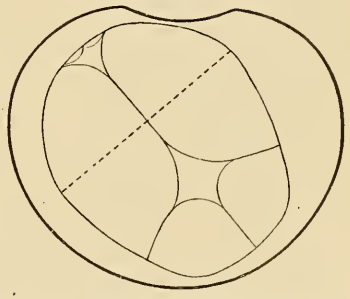


Fig. 140.—Occipito-Posterior Position of the Vertex (Herman.)
The dotted line indicates the bi-parietal diameter.

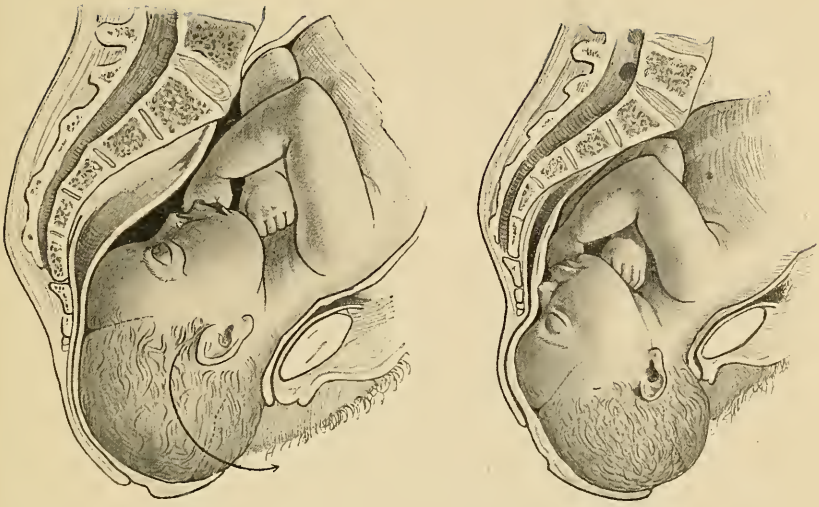
other hand, lies in the widest part of the pelvis where it can descend easily; consequently the head becomes extended.

Another possible factor in the production of backward rotation may also be mentioned. If the vertex is so extended as to make the occipito-frontal the diameter of engagement, the length of the transverse diameter of the pelvic cavity will form a mechanical obstacle to forward rotation of the occiput. This diameter measures $4\frac{1}{2}$ inches—*i.e.*, about the same as the occipito-frontal; yet, if forward rotation occurs, the head must pass through this diameter before the occiput can reach the pubic arch. It will clearly be easier for the occiput to pass backwards, thus bringing the diameter of engagement immediately into the long diameter of the outlet. If the vertex is flexed, no difficulty will be occasioned in forward rotation by the length of the transverse diameter. In the case of certain varieties of contracted pelvis the *inclined planes of the ischium* control the movement of internal rotation, but for the reasons stated on p. 413 they are probably inoperative in normal labour.

Fig. 141.—Fœtus from a Frozen Section of a Woman who Died in Labour towards the End of the Second Stage; showing Extension of the Trunk. (Barbour.)

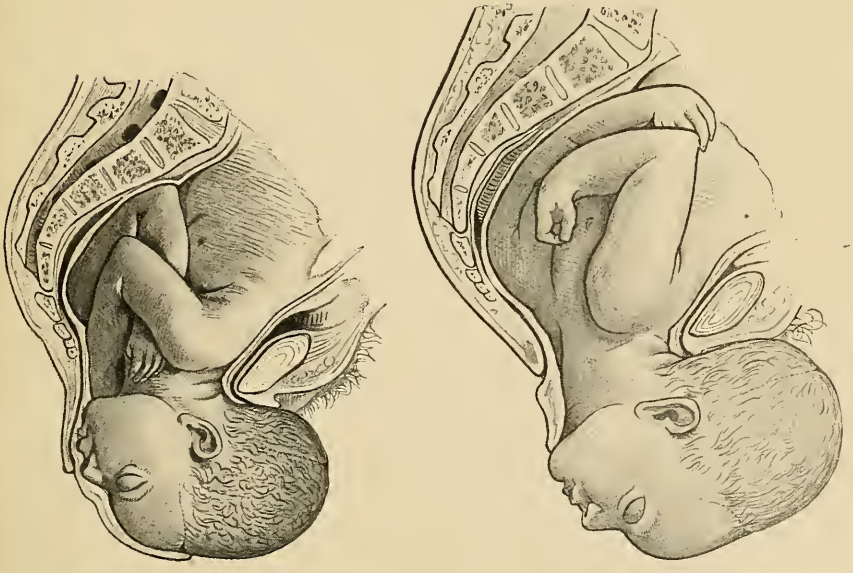
It will be understood from what has been said that, while backward rotation may exceptionally occur in anterior positions, this occurrence is extremely rare and can only be rendered possible by marked extension of the head. In posterior positions it occurs in about one case in ten. When backward rotation takes place the condition is called a *persistent occipito-posterior* or *face-to-pubes case*.

III. *Extension.*—After internal rotation has been completed the head emerges at the vulva, the occiput coming



(*a*) (*b*)

FIG. 142.—The Stages of the Movement of Extension in the Expulsion of the Head.



(*a*) (*b*)

FIG. 143.—The Stages of the Movement of Extension in the Expulsion of the Head.

first, then successively, the vertex, forehead, and face. When the chin slides over the edge of the perineum, it of course becomes separated from the chest-wall—*i.e.*, the head becomes extended. It is probable, however, that extension begins earlier than this, and is in fact part of a general change in the attitude of the fœtus which takes place towards the end of the second stage. The attitude of

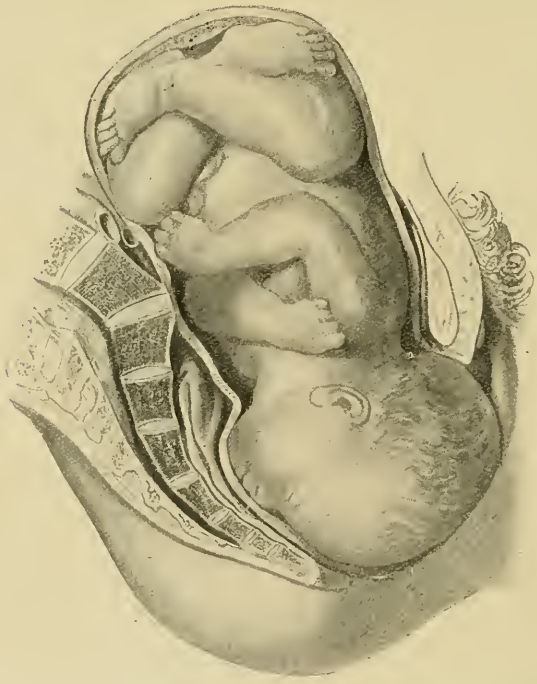


Fig. 144.—Showing the Position of the Shoulders before the Movement of External Rotation.

the fœtus shown in Fig. 141 is the same as that seen *in utero* in Fig. 142. When carefully examined it will be noticed that flexion of the trunk is not nearly so marked as before the onset of labour, this change being clearly indicated by the interval which here exists between the folded arms and the knees. The chin is also no longer in contact with the chest. In other words, extension has already begun; it is probably a normal occurrence at this stage of labour. Complete extension of the head only occurs, however, in the actual

process of expulsion through the vulva. The steps of this process are shown in Figs. 142 and 143. It will be observed that the interval between the chin and the chest wall progressively increases as the head is expelled, while the back of the neck becomes bent over the pubes.

IV. *Restitution and External Rotation.*—These are movements of the neck and trunk, the head being merely the

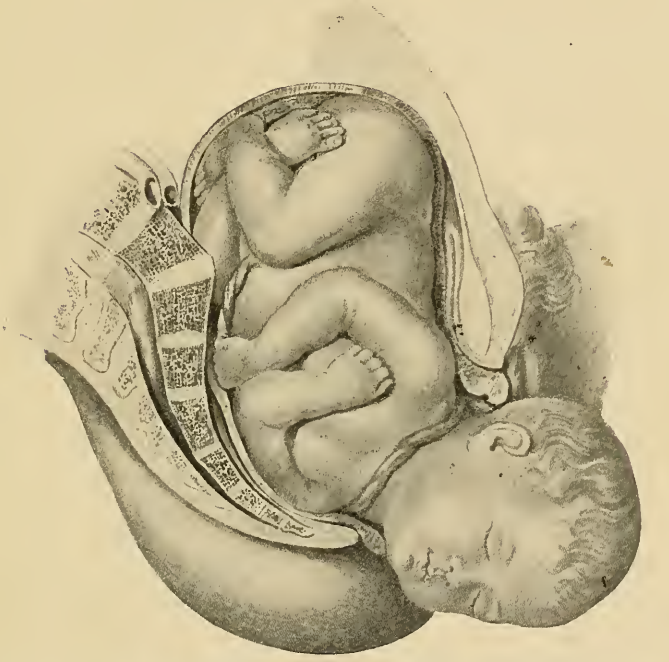


Fig. 145.—Showing the Position of the Head and Shoulders after the Movement of External Rotation.

index. (1) *Restitution.*—While the head is emerging in the antero-posterior diameter of the outlet, the shoulders engage in the oblique diameter of the brim (Fig. 144). In this attitude there is slight torsion of the neck, and when the head is free a slight movement occurs, bringing it back into its normal relation to the bis-acromial diameter. In first and fourth vertex positions this movement is represented by a slight turn of the occiput to the mother's left; in second and third to the mother's right.

(2) *External Rotation* represents the movement of the shoulders from the oblique diameter of the brim to the antero-posterior diameter of the outlet, in which they are born. The anterior shoulder rotates forwards under the pubic arch, and in first vertex positions this movement carries the occiput still further round to the mother's left, so that the face is now directed to the right thigh (Fig. 145). External rotation is thus a continuation of the movement of restitution.

It is unnecessary to describe separately the movements of the head in all four positions of the vertex. Posterior posi-

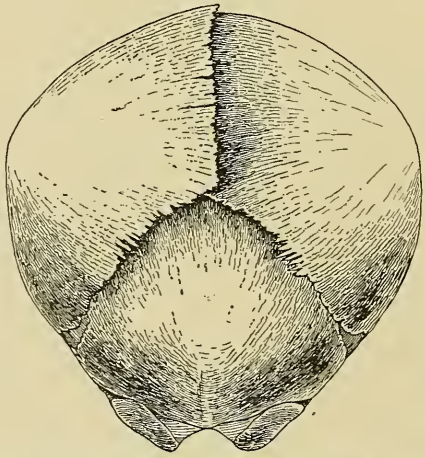


Fig. 146.—Head Moulding, showing Overlapping of Bones at the Lambdoidal and Sagittal Sutures. (Ribemont-Dessaignes and Lepage.)

tions differ from anterior chiefly in their liability to be associated with deficient flexion and in the variation of the movement of internal rotation which is thus brought about. As regards internal rotation, the conditions which induce forward or backward rotation have been indicated. In the movements of restitution and external rotation, the occiput always moves to the side where it lay at the commencement of labour.

Effect of Labour upon the Fœtal Head.—The pressure to which the head is subjected during labour occasions certain alterations in the relations of the movable bones of the vault of the skull to one another; these changes are termed

FIG. 147.—Slight Moulding of the Fœtal Head in Vertex Presentation, with small Caput about the middle of the Right Parietal Bone. (Bumm.)

The linear outline represents the shape of the head before labour.

FIG. 148.—Extreme Moulding of the Fœtal Head in Vertex Presentation, with Large Caput on the posterior part of the Right Parietal Bone. (Bumm.)

moulding of the head. The tabular portion of the occipital bone becomes depressed so as to deepen the posterior fontanelle, while the edge of the bone slides under the

posterior edges of the parietal bones (Fig. 146). The same change occurs, but to a less marked extent, at the sagittal suture ; one or other parietal bone becomes slightly depressed beneath its fellow along the sagittal suture. The general effect of these changes is also seen in an altered shape of the fœtal head ; the pressure of the girdle of contact is applied in the plane of the sub-occipito-bregmatic or sub-occipito-frontal diameters ; this plane therefore becomes somewhat compressed, while compensatory elongation occurs in the plane at right angles to it—*i.e.*, the occipito-mental plane. The head consequently becomes lengthened in its occipito-mental diameter (occipital tuberosity to point of chin) and shortened in its sub-occipito-frontal diameter (Fig. 147). The effect of moulding in occipito-posterior positions is described on p. 342. The degree of moulding met with is proportional to the pressure to which the head is subjected during labour ; in the case of an over-sized head or an under-sized pelvis extreme moulding of this type may occur (Fig. 148).

Fig. 149.—Caput Succedaneum in First Vertex Position. (Ribemont-Dessaignes and Lepage.)

The pressure of the girdle of contact upon the head also indirectly produces changes in the scalp. As the head is driven down, and the passages dilate, the part of the scalp lying in the centre of the birth-canal is free from pressure, while the part immediately above and around it is firmly compressed by contact with the maternal tissues. From interference with venous return effusion of serous fluid into the subcutaneous cellular tissue takes place upon the exposed area of the scalp, forming a swelling known as the *caput succedaneum*. It is clear that this change will occur at the end of the first and during the second stages of labour ; it is seldom met with until after the membranes have ruptured. In the *first position* of the vertex the right parietal bone lies in front of and below the left, and, owing to the flexed position of the head, the posterior end of the bone

lies at a lower level than the anterior. The exposed area therefore corresponds to the posterior end of the right parietal bone, close to the sagittal suture (Figs. 131 and 132), and in this position the *caput* forms. The size of the caput is proportional to the degree of compression—which again depends upon the relation in size of the head and the pelvis—and to the length in time which elapses between rupture of the membranes and expulsion of the head. The presence of a large caput upon the head is therefore an important sign of difficulty in labour. The side of the head upon which the caput is formed depends upon *position ;* its exact place upon the parietal bone depends upon the degree of *flexion* of the head. In first and fourth positions it is on the right parietal ; in second and third positions upon the left ; when the head is fully flexed it is placed far back, close to or overlapping the posterior fontanelle ; when the head is incompletely flexed it will be found more anterior, and may even be near the anterior fontanelle. The usual location of the caput is therefore as follows :

1st position	Posterior end of right parietal
2nd ,,	Posterior end of left parietal
3rd ,,	Middle or front of left parietal
4th ,,	Middle or front of right parietal

But if in third and fourth positions the head is well flexed, the *caput* will be formed nearer the posterior part of the bone.

If after internal rotation has occurred the head is long delayed on the pelvic floor, a *caput* will form upon the part of the scalp which presents at the vulva—*i.e.*, the region of the occipital bone near the posterior fontanelle. This is sometimes called the *secondary* caput succedaneum ; its place is the same in all positions of the vertex when forward rotation of the occiput has occurred ; it will be found upon the sinciput in face-to-pubes cases.

It will be seen that the position of the *caput* and the nature of the moulding are useful indications of the position occupied by the head in the pelvic cavity. They must be noted immediately after birth, as moulding often disappears in a few hours, and the caput is always absorbed in from twenty-four to forty-eight hours.

The Management of Normal Labour

In this section will be considered (I.) antiseptics ; (II.) diagnosis ; (III.) management.

I. Antiseptics.—Every case of labour must be conducted with the most scrupulous attention to surgical cleanliness on the part of all who are in attendance upon the patient. Puerperal infection is due in the overwhelming majority of instances to the introduction of pathogenic organisms into wounds of the genital canal ; there may be a few exceptions to this rule, but they do not impair its general force. Under ordinary circumstances surgical cleanliness in obstetric work cannot be attained without the free use of antiseptics ; it is probable that ' aseptic ' midwifery will always be restricted to lying-in institutions. The great majority of women will no doubt at all times prefer to give birth to their children in their own homes, where circumstances are usually unfavourable to the organisation of the innumerable details of aseptic work.

Preparations.—The greatest care must of course be taken in preparing instruments, catheters, douche tubes, etc., before use. These and other obstetric instruments such as forceps can conveniently be boiled immediately before use in the patient's room in the obstetric steriliser shown in Fig. 150. This appliance is made of suitable length to take the usual obstetric instruments, and can be carried in a bag of ordinary size. Before use they must then be taken carefully from the steriliser and *immersed* in a solution of carbolic acid 1 in 40, out of which they should be taken only for immediate application. Catheters and douche nozzles should always be boiled immediately before use.

The *vulva* always requires disinfection ; in the case of cleanly persons this is comparatively easy ; in women whose habits and surroundings are uncleanly it may be very difficult, so that the vulva becomes a definite source of possible infection. It would, without doubt, be an advantage in all cases to shave and disinfect the vulva as for a surgical operation, but this would be misunderstood and resented in private practice. The vulva should, however, be shaved under anæsthesia before performing any of the obstetric operations. Whether shaved or not the vulva

should be well cleansed with soap and water, then with fresh water, and finally thoroughly swabbed with an antiseptic solution ; for this purpose carbolic acid (1 in 40) or one of the coal-tar products such as lysol or izal (1 in 160—*i.e.*, a teaspoonful to a pint) is preferable to mercurial solutions, for frequent swabbing is required during labour, and the mercurial solutions when freely used cause a good deal of irritation of the mucous surfaces. Only perfectly clean and fresh linen, or clean pads of absorbent wool, should be allowed, after the external genitals have been disinfected, to come in contact with them. Sets of sterilised swabs and towels, prepared for use during labour, can be obtained from surgical instrument makers. The *hands* and

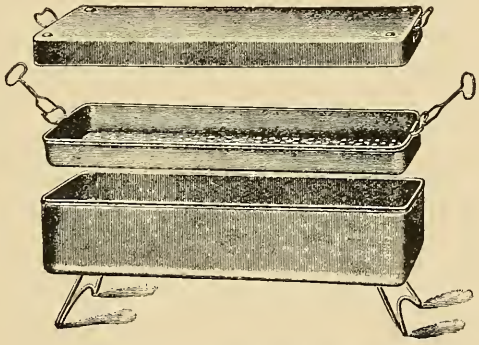


Fig. 150.—Obstetric Steriliser.

forearms of the medical attendant and the nurse should first be scrubbed for five minutes in hot water and soap with a *boiled* nail-brush ; then the soap rinsed off in fresh hot water, and the hands finally immersed for two to three minutes in a solution of 1 in 1,000 biniodide or perchloride of mercury. It is almost superfluous to point out that it is impossible to sterilise the hands without first removing the coat, turning the shirt-sleeves up above the elbows, and removing rings from the fingers. If the hands have recently been infected from contact with a septic midwifery case or a suppurating wound, especial care must be taken, for it is well known that skin actually infected with pathogenic organisms is extremely difficult to sterilise, and the usual process should be repeated two or three times. Under these circumstances rubber

gloves, previously boiled for ten minutes, should also in all cases be used. If the precautions mentioned above are taken, the routine use of rubber gloves in conducting labour is unnecessary, and their cost forms an obstacle to their general adoption in all classes of midwifery practice. But in the cases of patients suffering from infectious discharges, whether of specific or septic origin, sterilised gloves should always be worn not alone in the patient's interest, but also to protect the hands of the attendant from infection, and thus render it practicable for him to attend other cases with safety.

It will be observed that this technique falls short in some respects of that considered necessary for surgical operations. Strict surgical technique would require complete shaving and disinfection of the vulva before delivery, the use of sterilised rubber gloves by the medical and nursing attendants, and the provision of a large and costly supply of sterilised dressings, towels, coverings, etc. This again would involve the provision of hospital accommodation for all confinements among the poorer classes of society. For a normal confinement such elaborate technique is unnecessary, because internal manipulation can be reduced to a minimum ; but when interference requiring internal manipulation is required, the fullest surgical technique is a necessity.

It must be remembered that clothing also becomes infected by contact with septic discharges, and possibly also by exposure to the atmosphere of an ill-ventilated room in which a septic case is lying. Therefore, in the case of an obstetric nurse who has attended a septic case, the disinfection of her clothing becomes a matter of the greatest importance, and it is the duty of the medical man under whom she works to see that these precautions are carried out. All washable articles should be boiled ; the others should be sent to the local sanitary authority, by whom they will be efficiently disinfected by heat. What is requisite for the nurse is also requisite for the medical attendant, although the danger in his case is less because he is not exposed to the risk of contact with septic material for such a long period as the nurse. A complete change of clothing is, however, absolutely necessary before passing from a case of infectious fever, of puerperal or surgical infection, or of suppuration

of any kind, to one of normal labour. When a septic case has been examined without gloves being used, repeated disinfection of the hands must be carried out, and gloves used for all purposes; it is well recognised that skin which has been exposed to contamination by virulent bacteria is exceptionally difficult to sterilise. If these precautions are taken, it is not necessary for the medical attendant or the nurse to be suspended from obstetric work for a longer period than is required for the due performance of the various steps in disinfection; mere abstinence from work and lapse of time (although the latter may diminish the virulence of organisms deposited upon skin or clothing) are not disinfecting agents; they cannot be relied upon alone, and if other methods are efficiently practised they are unnecessary.

Of the many antiseptic substances employed in surgery, there is a general consensus of opinion that the mercurial salts are the most reliable for the disinfection of the skin. Biniodide is preferable to perchloride of mercury, because it is a slightly more powerful germicide, does not roughen the skin when frequently used, and does not coagulate albumen, nor corrode steel instruments. The bactericidal action of a solution of biniodide of mercury is increased by an admixture of alcohol in the proportion of three parts of solution to one of methylated spirit. Rubber, glass, or metal instruments should all be sterilised by boiling.

The question of vaginal douching will be most conveniently considered when dealing with the puerperium (p. 544), but it may be stated here that douching is unnecessary before or during labour in a normal case when the vaginal canal is healthy. When the membranes rupture, and again when the body of the child escapes, the passages are flushed from above with a large quantity of sterile fluid (the liquor amnii), which serves all the mechanical purposes of a douche and has none of its attendant risks. Sometimes the amniotic sac becomes infected during labour, usually after, but sometimes before, rupture of the membranes, and then of course this advantage is lost, and if the condition is recognised douching should be employed. The best solution to use *during labour* is peroxide of hydrogen, in the strength of 5 volumes; this is a non-toxic and non-irritating solution.

The presence of a purulent or muco-purulent vaginal discharge also indicates the necessity for careful douching before labour; the best antiseptics under such circumstances are lysol 1 in 160 or biniodide of mercury 1 in 4,000.

II. Diagnosis.—The first examination of a woman in labour should be directed to the recognition of the three following points, which are of great practical importance: (1) the presentation and position; (2) the relation between the size of the fœtal head and that of the pelvis; (3) the presence of the fœtal heart-sounds. These matters must be

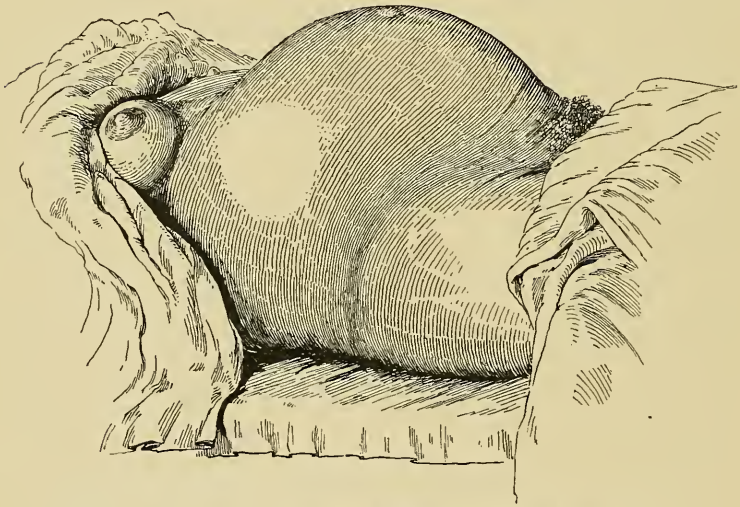


Fig. 151.—The Abdomen of a Pregnant Woman at Term.

settled at the beginning of labour, and accordingly the examination should be made as early in labour as possible, unless the medical attendant has taken the precaution, advised on p. 105, of making the diagnosis of these points during the latter part of pregnancy. Only by this method can causes of obstruction be recognised in time to avoid the serious maternal and fœtal dangers to which they give rise, when their presence is not detected until labour is advanced. Both abdominal and vaginal examination will be required. The signs which indicate that labour is actually in progress have been already described (p. 243).

Abdominal Palpation.—Nearly all the information re-

quired at this stage can be obtained by examination of the abdomen ; no risk or discomfort to the patient is involved in it, and it may accordingly be freely employed. A certain amount of skill, which can only be attained by practice, is required, and the details of palpation are much more readily learned during pregnancy, when the uterus is quiet, than during labour, when it is actively contracting ; the student

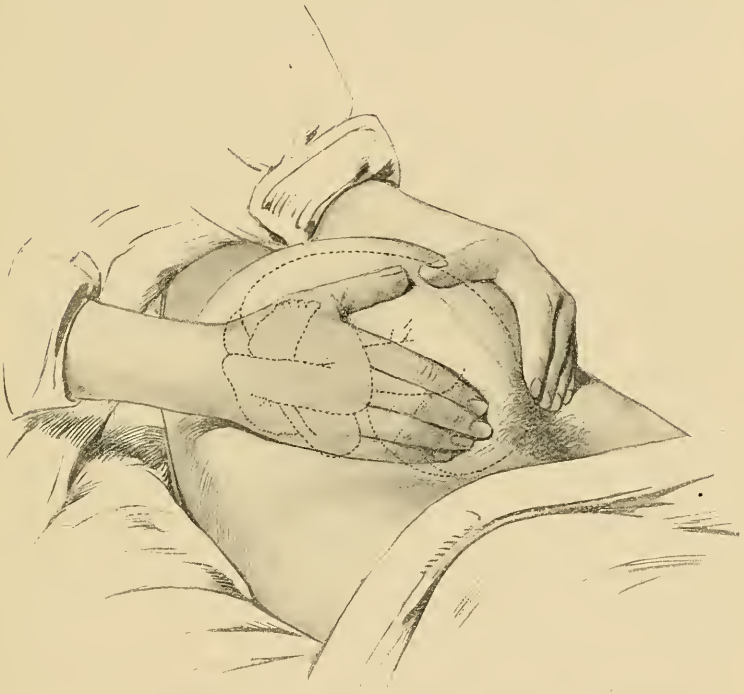


Fig. 152.—Abdominal Palpation. Step I. Palpating the Head by the *first pelvic grip*.

should therefore miss no opportunity of practising this method during the latter weeks of pregnancy.

The patient should lie upon her back with the shoulders slightly raised, the knees slightly bent, and the abdomen completely uncovered. The hands should be warm, and should be used with gentleness ; if labour is actually in progress, the manipulations should be suspended during the pains. The level of the fundus should first be noted ; it will usually be found about a hand's breadth below the tip

of the ensiform cartilage. The parts of the body of the fœtus which can be recognised by palpation are the head, the breech, the back, the anterior shoulder, and the folded limbs lying upon the ventral aspect. In normal labour the head lies in the lower uterine segment and the breech at the fundus, and this is the only arrangement with which we are here concerned. The lower pole of the fœtus should first be palpated by placing the hands flat upon the lower part of the abdomen, in the position shown in Fig. 152 ; the finger-tips are then directed downwards and inwards and steady pressure is made so as to force them towards the pelvic brim, and at the same time approximate them to one another. This is called the *first pelvic grip*, and by it, in a vertex presentation, the head of the fœtus may be grasped between the two hands and its distinctive characters made out.

It is not in all cases equally easy to feel the head distinctly. Thus in a primipara the head may have descended into the pelvic brim, so that very little of its surface is accessible to the touch of the finger-tips. In a multipara the level of the head early in labour is higher, and a better impression of its shape and outlines can be obtained. In all cases it can be recognised that the head forms a mass of densely hard consistence, and when it lies low in the brim there is very little mobility. When the head lies higher it can be readily moved from side to side, and the details of its shape more easily made out. Usually the patient experiences distinct pain on pressure over the head, but not over any other part of the fœtus.

When the head is fairly high its oval shape can be recognised, and also the direction in which the long diameter lies ; usually also the sincipital and the occipital ends of the ovoid can be discriminated. Before labour has set in the long diameter of the head is not infrequently found to occupy the transverse diameter of the pelvic brim ; when labour is actually in progress it will be found usually in one of the oblique diameters. The sincipital end of the long diameter is broader, more prominent, and more irregular in outline than the occipital end ; but it is only in cases in which the conditions are favourable for palpation that these points can be made out. The head can be distinguished from the breech at the pelvic brim by the following points :—It is

harder than the breech, better defined in outline, and is separated from the trunk by a groove corresponding to the neck ; by firmly drawing the fingers upwards from the head to the trunk the presence of this groove can usually be determined. In a multipara the head usually lies above the level of the plane of the brim at this stage of labour, and therefore it can be more easily grasped. The head may then be better felt by the *second pelvic grip,* in which the ulnar margin of the hand is placed upon the pubes, and the thumb and fingers spread so as to include the head between them

Fig. 153.—Abdominal Palpation. Step I. Palpating the Head by the *second pelvic grip.*

(Fig. 153). It will be evident that the second pelvic grip will be more useful when the head is high, the first pelvic grip when the head is low. In the former case the head can be readily moved from side to side ; in the latter case, as it lies in the pelvic brim, it is almost immovable.

The fundus of the uterus is next palpated with the two hands laid flat upon it (*fundal grip*), the observer reversing his position so as to stand facing the patient (Fig. 154) ; the breech in this position will be felt to be larger, softer, and more irregular in outline than the head ; one buttock can often be felt as a firm, distinctly rounded prominence. The

buttock is, however, much smaller than the head, and can often be felt to rotate beneath the fingers as the trunk of the fœtus moves spontaneously round its vertical axis. Small rounded prominences representing the feet are usually to be felt in the same region as that in which the buttocks lie ; there are, however, certain exceptions to this statement (p. 361). These small parts can be readily displaced by the

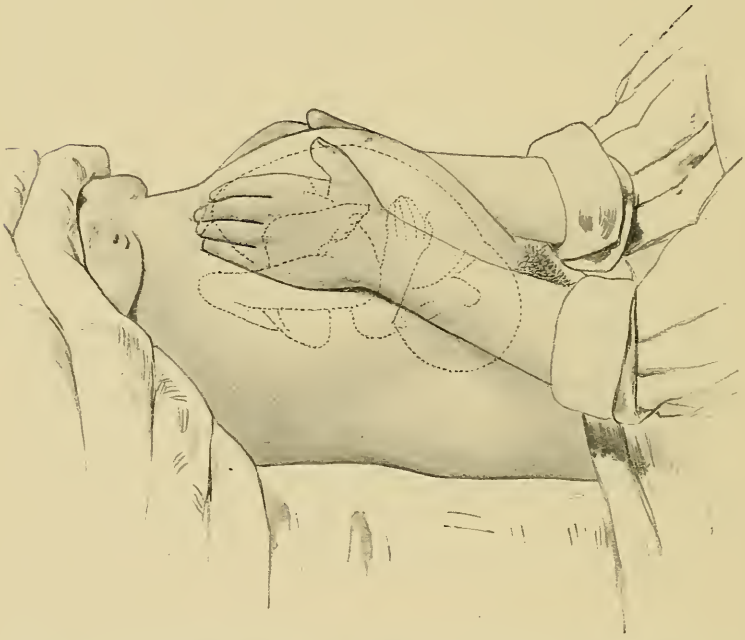


Fig. 154.—Abdominal Palpation. Step II. Palpating the Breech by the *fundal grip.*

observer, and can often be felt to make vigorous spontaneous movements.

The front and sides of the uterus are next to be palpated (*lateral grip*) in order to locate the back and the limbs (Fig. 155). It will be remembered that the head engages in one or other oblique diameter of the brim ; in the first and second positions a large area of the back is accessible to palpation ; in the third and fourth positions, however, only a small part of the back is accessible, while the limbs will be readily felt (Fig. 128). These differences in the disposition of the fœtal

parts lead to a certain difference in the shape and outline of the uterus which can be observed on inspection in a favourable case. Thus in anterior positions the anterior abdominal wall forms a boldly marked convexity of uniform outline, while in posterior positions it is distinctly flatter, and in thin subjects it is irregular in outline over the position of the

Fig. 155.—Abdominal Palpation. Step III. Palpating the Back and Limbs by the *lateral grip*.

folded limbs. Irregularities of outline corresponding to the limbs can often be observed at one or other side of the uterus in an anterior position. On palpation the back forms an extensive, smooth, rounded area, over which the fingers pass without interruption. The limbs, on the other hand, are felt as irregularities, or as definite knobs, which can be displaced by the fingers, and which can also often be felt to make spontaneous movements. In anterior positions

the back appears to occupy the greater part of the uterus, while the limbs are only to be felt well to one or other side of the mid-line. In posterior positions the back may not be definitely recognised at all, while the limbs are recognisable on *both sides of the mid-line.*

The position of the anterior shoulder should also be sought. It forms a well-marked prominence in the lower part of the uterus a little above the head (Fig. 126) and will be found to the right of the middle line in second and third positions, to the left in first and fourth positions: it is nearer the middle line in anterior than in posterior positions.

It will now be apparent that it is possible to make a complete diagnosis of presentation and position from abdominal palpation alone. Thus the head is in the pelvic brim—*vertex presentation;* the back is readily felt—*anterior* (*first or second*) *position;* in addition, the limbs are to the right of the middle line—*first position;* or the back cannot be located, but the limbs are readily felt—*posterior* (*third or fourth*) *position.* It must, however, be recollected that the four 'positions' of the vertex recognised in the British system of midwifery are not the only positions in which the head may lie. It may take up an intermediate position between the first and fourth, or between the second and third, and also, though more rarely, between the first and second. Cases will, therefore, occur in which the exact 'position' of the head cannot be defined as belonging to either of the four recognised 'positions.'

Auscultation of the fœtal heart also yields valuable information in diagnosis; not only does it indicate presentation and position by the locality over which it is audible, but when heard it also proves that the fœtus is living, while by the changes which it undergoes during labour timely warning of danger to the fœtus may be given.

The fœtal heart-sounds can best be heard by using a single wooden stethoscope and pressing it firmly against the abdominal wall over the back of the fœtus (Fig. 156). The part of the fœtal back over which the heart-sounds are best heard is the scapular region. The position occupied by this area in relation to the mother's abdominal wall varies with both presentation and position (see Figs. 126 to 129), and

the stethoscope must be moved from place to place until the point of *maximum intensity* of the sounds has been located. Often they can be heard over a wide area of the abdomen, and it is then important to fix the point at which they are loudest. In the first position of the vertex the heart-sounds are heard best at a point about midway between the umbilicus and the left anterior superior iliac spine (Fig. 157). This point corresponds almost exactly to the position of the left scapula, *i.e.*, the point on the fœtal body at which the heart-

Fig. 156.—Showing the usual Position of the Point of Maximum Intensity of the Fœtal Heart-sounds in a Case of Second Position of the Vertex.

sounds will be most clearly heard. In the second position the point of maximum intensity is less definite. Often it is in the middle line, half-way between pubes and umbilicus ; almost as often it is somewhere about the centre of a line drawn from the umbilicus to the right anterior superior spine. In the second position the left scapula is not in contact with the abdominal wall, and the point upon the back of the fœtus where the heart sounds are most clearly heard is variable. In the third position they are usually best heard at a slightly higher level, but further from the middle

line towards the flank ; occasionally, however, they will be best heard in the mid-line, rather nearer the umbilicus than the pubes. When heard in the latter position there is probably sufficient extension of the trunk to throw the chest forwards against the anterior uterine wall. In the fourth position it is more difficult to find the heart-sounds than in

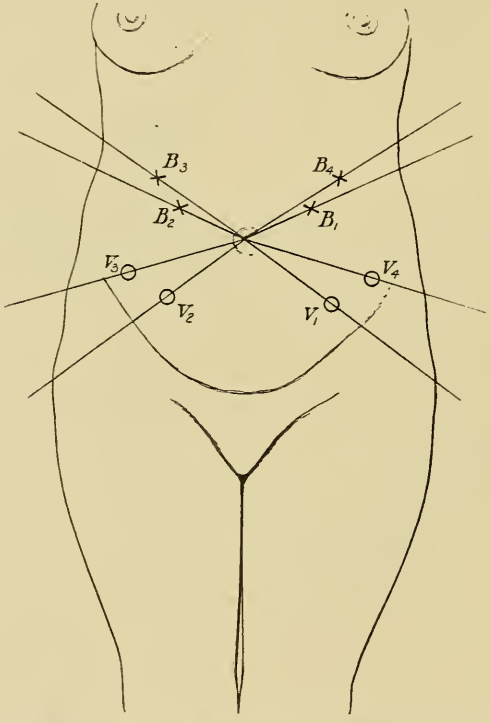


FIG. 157.—The Points of Maximum Intensity of the Fœtal Heart-sounds in Vertex and Breech Presentations.

V = vertex presentation. B = breech presentation.

any other. When heard they are usually found well outwards towards the left flank. When palpation fails to settle the diagnosis of position, it is clear that valuable aid can be obtained by localising the point of maximum intensity of the fœtal heart-sounds.

The *rate* of the fœtal heart-sounds at term varies from 120 to 140 per minute ; sex has no definite influence upon the rate, nor has size, although some observers believe that

a large child has usually a slower heart-beat than a small one. The fœtal heart-rate is slowed during the uterine contractions, but quickly recovers when they pass off. Progressive slowing of the rate during prolonged labour indicates that the fœtus is suffering from the effects of pressure, and forms an indication for rapid termination of labour. Undue rapidity is also an unfavourable sign. If the rate falls below

Fig. 158.—Method of making a Vaginal Examination during Labour. The Labia are held apart by Two Fingers of the Left Hand while the Right Index Finger is passed into the Vagina.

100 or rises above 160, danger to the child is certain. It is accordingly of importance to count as well as to locate the fœtal heart-sounds.

Vaginal Examination.—This method must be employed as little as possible during labour, owing to the attendant risks of infection. Nearly all the information required can be obtained, as we have seen, by abdominal examination alone, and in normal labour vaginal examination for diagnosis is often unnecessary. It may, however, be required to

determine the onset of labour, or to watch the process of dilatation of the cervix.

In making a vaginal examination of a parturient or lying-in woman, the medical attendant should first disinfect his own hands and then the vulva of the patient, if no nurse is present to do this. The hands are then again immersed in the antiseptic solution, and, while the fingers of the left hand separate the labia, the index finger of the right hand is carefully passed into the vagina, avoiding all contact with the vulval hair, the patient's clothing, or bed-clothes (Fig. 158). In making the examination the hands should be used dripping

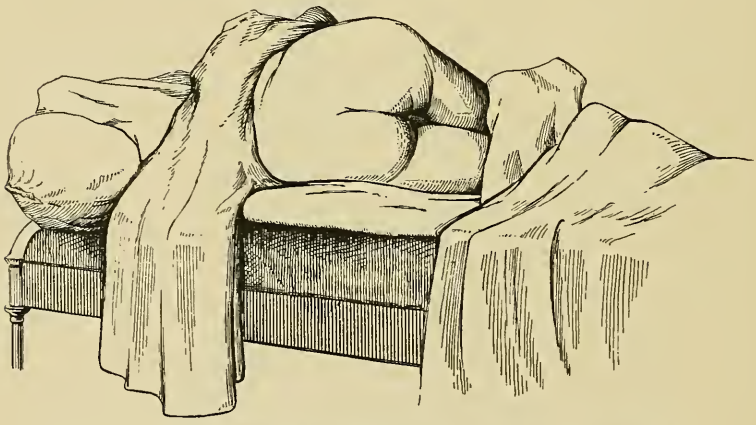


Fig. 159.—The Left Lateral Position. Patient prepared for Vaginal Examination.

wet with the antiseptic solution ; no unguent is necessary, for the wet fingers will not cause the patient the least discomfort, and it is well known that the so-called antiseptic unguents possess no bactericidal properties, and may even be a source of danger, for in some of them bacteria in a living state may exist for a long time. When it is necessary to repeat the examination the hands must again be disinfected, and the vulva swabbed with the antiseptic solution.

For a vaginal examination during labour the British practice is to place the patient upon her left side, and in this position women are usually delivered (Fig. 159). Modifications of this posture are required under special circumstances which will be afterwards indicated. In making the first

vaginal examination certain definite objects must be kept in view, and systematically dealt with one after the other ; unless this is done no information of value may be obtained, or the student may find it necessary to repeat the examination in order to determine something he has forgotten, and this needlessly increases the risks. The points should be observed in the order stated : (1) the level at which the head lies in the pelvis ; (2) the size of the dilating cervix and the condition of its walls ; (3) the presence or absence of a bag of waters ; (4) the position of the posterior fontanelle.

The *level* at which the head lies during the first stage of labour is different in a primigravida and a multigravida. In the former, if the conditions are normal, the head is low enough to be readily felt by the finger in the vagina without making upward pressure to reach it. This signifies that the head is ' engaged ' in the brim, *i.e.*, the greatest circumference of the head corresponds with the brim, while the vertex is in advance and therefore lies lower. If in a primigravida the head cannot be thus readily felt, suspicion is at once aroused that some cause of *obstruction* is present. The ' engaged ' head has little mobility, but can be pushed upwards to a slight extent during the intervals between the pains.

In a multipara the head usually lies above the brim, and not ' engaged,' until the end of the first stage. It can then be felt only by making upward pressure with the finger, and it will be found to be freely movable during the intervals of the pains.

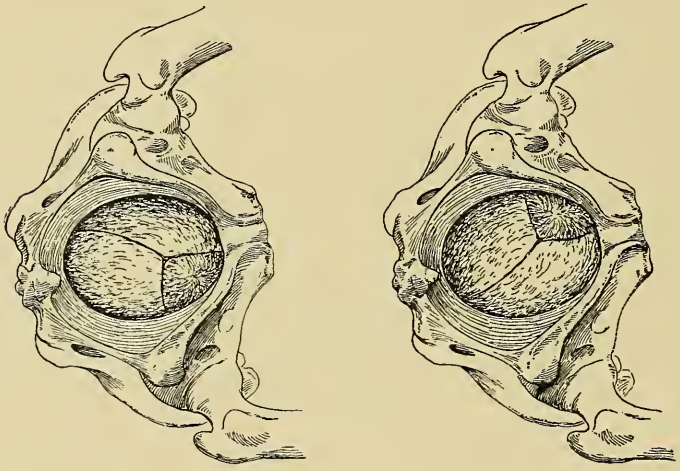
The walls of the *cervix*, and the margins of the external os should feel soft and yielding to the touch ; during a pain the margins of the os may become stretched tightly over the head, but in the intervals they are quite soft. In a primipara the cervix may become completely ' taken up ' before the os is one-third or one-half dilated ; the os then appears to the examining finger as a circular aperture in the tightly stretched cervical wall. In a multipara the cervix dilates more uniformly.

The *bag of waters* may escape notice altogether unless the examination is continued during a pain ; in the interval it does not bulge, the membranes lying in contact with the

head. If the hairy scalp can be recognised by the finger it is obvious that there is no bag of waters.

The *posterior fontanelle* will be detected if the head is well flexed, as explained below.

While the cervix is undilated and the membranes are unruptured, the sutures and fontanelles cannot be distinctly felt, and great care must be exercised in avoiding accidental rupture of the bag of waters. Diagnosis of position by vaginal examination must usually be postponed until the



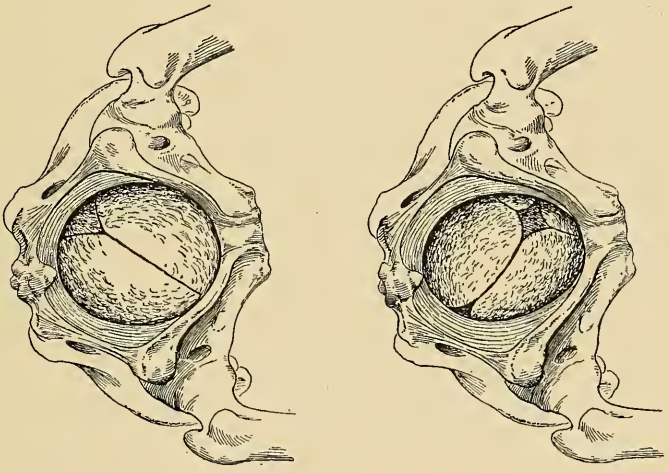
a *b*

FIG. 160.—*a*. First Vertex Position, showing Relations of Posterior Fontanelle and Sagittal Suture. *b*. Second Vertex Position. (Modified from Ribemont-Dessaignes and Lepage.)

Patient in usual obstetric position.

second stage, when the necessary particulars can be made out without difficulty. In the *first* position the posterior fontanelle will be felt in the left anterior quadrant of the pelvis ; the sagittal suture runs backwards and to the right in the line of the right oblique diameter, and the anterior fontanelle is out of reach (Fig. 160 *a*). When internal rotation has occurred, the posterior fontanelle will be found in the middle line anteriorly. The disposition of the sutures and fontanelles in the second position is shown in Fig. 160 *b*. In the case of the posterior positions, the degree of flexion present influences the disposition of the sutures and fonta-

nelles to a considerable extent ; when the head is flexed, the posterior fontanelle can be felt in one or other posterior quadrant of the pelvis, the anterior fontanelle being out of reach (Fig. 161 *a*). If, however, flexion is deficient, the anterior fontanelle comes within reach and can be felt in the anterior quadrant of the pelvis, while the posterior fontanelle can barely be reached at all (Fig. 161 *b*). Sometimes difficulty arises in the second stage owing to the formation of a large caput succedaneum which obscures the



a *b*

Fig. 161.—*a*. Third Vertex Position, Head flexed. *b*. Fourth Vertex Position, Head partly extended, showing Anterior and Posterior Fontanelles and Sagittal Suture. (Modified from Ribemont-Dessaignes and Lepage.)

Patient in usual obstetric position.

sutures and fontanelles. The best guide to position then is the ear, which can easily be reached when the head is low ; the curve of the helix is towards the occiput.

III. **Management of the First Stage.**—There is little for the medical attendant to do during this stage after the diagnosis has been satisfactorily made ; a skilled nurse is quite as well able to attend to the patient's wants and watch the course of labour as a qualified medical practitioner. A single vaginal examination for diagnostic purposes at this period should be enough ; if repeated, it should be with the definite

object of observing the progress of dilatation and the advance of the head. Any succeeding examination should be conducted with strict and conscientious antiseptic precautions.

During this stage the patient may be allowed to walk about or sit, or assume any position in which she is for the time easy. An enema should be given as soon as labour has definitely begun, to ensure the rectum being empty at the time of delivery; and evacuation of the bladder from time to time should be secured, either spontaneously or by the use of the catheter if necessary. Nourishment can be given freely if the patient is not sick; vomiting at this stage is neither unusual nor of serious import. While regularly recurring pains are present it may be assumed that labour is progressing normally. If the pains are irregular, or only imperfectly intermittent, progress is usually slow, and it may then be necessary to observe the condition of the cervix. The first change is that it becomes 'taken up,' *i.e.* the projection of the vaginal portion into the vaginal canal disappears. In a primigravida the dilating cervix now becomes tightly stretched by the advancing vertex, and when examining during a contraction the ring formed by the os externum will be felt to be firm and well-defined, the bag of waters bulging through it; in the intervals it becomes soft and relaxed, while the head recedes and the bag of waters becomes collapsed and may be difficult to recognise. The progress of dilatation is usually recorded by noting the size of the os externum, as—admitting one finger, size of half a crown, size of a crown piece, half dilated, three fourths dilated. When fully dilated the anterior lip of the os is still palpable between the head and the pubes, but the posterior lip will have disappeared, as it has been drawn up above the advancing head.

As soon as the membranes rupture, whether at the end of this stage or prematurely, a second vaginal examination should be made. The hairy scalp can now be distinguished by the finger and the disposition of the sutures and fontanelles made out with comparative ease and the diagnosis of position thus confirmed. The transition from the first to the second stage is marked by a change in the condition of the patient and in the character of the pains, which has been

already described. In a normal labour proceeding without undue delay, two vaginal examinations, one at the start and one after rupture of the membranes, are all that is required.

Apart from the slightly blood-stained 'show' at the commencement of labour, there is no hæmorrhage during the first stage in a normal case. No anæsthetics or sedatives should be given when this stage is running a normal course.

Management of the Second Stage.—During this stage the patient must lie down; the medical attendant cannot leave her except for a very short time, and he should even then remain within easy call. The pains of this stage are severe, and the voluntary efforts of the accessory muscles exhausting. The patient should, however, be encouraged to continue as long as possible without anæsthesia, as voluntary bearing-down efforts greatly assist the descent of the head. Towards the end of this stage chloroform may be given. Surgical anæsthesia is not required except at the time of actual delivery, when the head is emerging from the vulva; the pains then become very severe, and are accompanied by violent straining which may do harm. Partial anæsthesia may, however, be maintained during the latter part of this stage without injury to the patient or the fœtus; it is best carried out by the administration of chloroform by the open method upon a handkerchief or a flannel mask. If an inhaler is preferred, that of Junker is the safest and most convenient. Chloroform should be given only during the pains; in this way sufficient will be taken to relieve the patient's suffering and cause her to sleep during the intervals. While no harm ever comes from giving chloroform to a healthy woman for a considerable time in this manner, it should be remembered that complete anæsthesia, when prolonged, may lead to uterine inertia and troublesome post-partum hæmorrhage. The fœtal heart should be auscultated from time to time when the second stage is unduly prolonged.

Even in cases where a complete diagnosis has been made in the first stage by external examination, a vaginal examination should be made early in the second stage to confirm the previous diagnosis, and to note any changes which may have occurred. The head has usually descended sufficiently to

allow the whole area of the presenting part to be reached by the finger. First the lip of the os externum should be sought; the anterior portion alone will be felt, and its condition should be noted ; not infrequently it becomes swollen from œdema induced by compression between the head and the pubes ; normally it is felt as a soft, thick fold of tissue. By sweeping the finger-tip round the presenting part the os will also be felt at the sides and behind, if it is incompletely dilated. Next the condition of the scalp should be noted ; a small caput may be detected, the pitting of the tissues on pressure being recognisable by touch. A large caput at this period of the second stage is abnormal and indicates some degree of obstruction. Next the sutures should be sought for and special attention paid to the points where sutures can be felt to meet ; these positions correspond to the fontanelles, and usually only one is within reach. The distinction between the anterior and posterior fontanelles is by no means so easily made during labour as upon the fœtal skull. The bones are compressed, and the size of the fontanelles considerably reduced. Further, if the fontanelle is not readily accessible an erroneous impression may be produced by feeling only a portion of it ; thus if the anterior fontanelle is difficult to reach so that only one corner of it is felt, three sutures only may be discovered, and in consequence it may be mistaken for the posterior. During labour the depression of the occipital bone beneath the parietals is exaggerated by compression so as to deepen the floor of the posterior fontanelle and throw up the edges of the parietal bones to an unmistakable degree. In the case of the anterior fontanelle the bones are on a more uniform level, and this point is therefore one of great diagnostic importance. After satisfactorily recognising the fontanelle an attempt should be made to define its position in the pelvis, and for this some experience is required. When the posterior fontanelle is felt it usually lies in the anterior half of the pelvis at this stage of labour, and inclined slightly to one or other side. Later on in labour, after internal rotation has occurred, it will be found in the middle line, behind or beneath the symphysis. The anterior fontanelle is seldom felt except in occipito-posterior positions.

It is unnecessary to make vaginal examinations to watch

the descent of the head, for the appearances described on p. 252 will indicate when the head has reached the vulva. The work of the medical attendant may then be said to begin, his duty being to control the passage of the head and body of the fœtus through the vulva, and as far as possible to avoid injury to the pelvic floor. In this country women are usually delivered lying upon the left side, with the thighs partly flexed and the knees held apart by an assistant.

Time should be allowed for the actual expulsion of the head, especially in the case of a primipara, or whenever the perineal body appears to be unusually resistant. If delivery is taking place under anæsthesia it will usually be observed that as the degree of anæsthesia deepens the pains become weakened and delayed. Sometimes this effect is so marked with only slight degrees of anæsthesia that labour practically comes to a standstill and the administration of chloroform has to be stopped. During the delivery of the head rapid progress is, however, undesirable, and the administration of chloroform should be pushed so as to produce surgical anæsthesia. It is usual to speak of the process of assisting the delivery of the head as 'supporting the perineum.' This expression is unfortunate, for attention should be mainly directed not to the perineum, but to the head ; no amount of support applied to the perineum will prevent a threatening laceration unless the movements of the head can be properly directed. The object in view is to deliver the occiput first, and to prevent extension of the head from taking place until the bi-parietal diameter is free from the vulva. This implies that the natural tendency to extension of the head at this stage must be resisted up to a certain point. By making pressure upon the stretched perineum with the palm of the hand, and at the same time allowing the occiput to protrude beneath the symphysis, the head will be kept from extending until the wide posterior part (bi-parietal) diameter) has escaped. The head may then be allowed gently to extend at the end of a pain, the face and chin being slowly levered over the perineum during an interval. This method has a definite mechanical advantage. If the head does not extend until the parietal eminences are free, extension brings successively the sub-occipito-bregmatic, sub-

occipito-frontal, and sub-occipito-mental diameters (each measuring about $3\frac{3}{4}$ inches) through the antero-posterior diameter of the outlet (Fig. 162). If, however, the head should extend before this, the occipito-frontal ($4\frac{1}{2}$ inches) or the occipito-mental (5 inches) diameters must pass through the outlet, or, if not these, then certain intermediate diameters necessarily longer than the sub-occipito-bregmatic and sub-occipito-frontal. It will thus be seen that the important point is not the support given to the perineum,

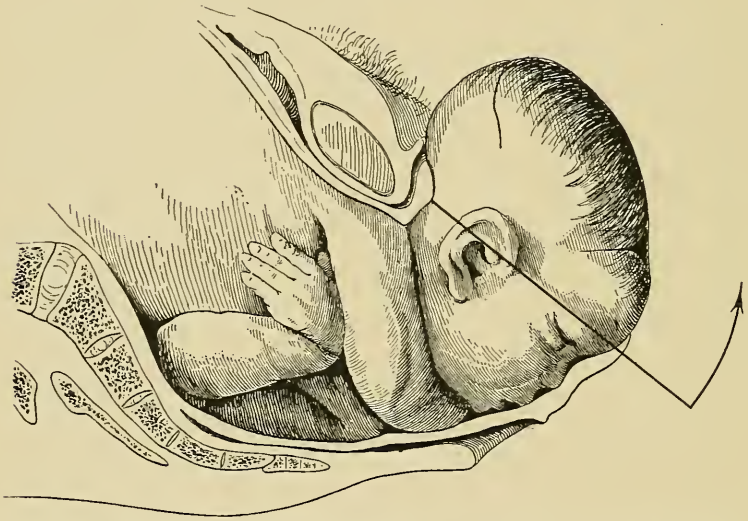


Fig. 162.—Extension of the Head (Third Movement) in passing the Pelvic Outlet; Sub-Occipito-Frontal Diameter engaged; the Bi-parietal Diameter is free. (Bumm.)

but the attitude of the head when escaping from the vulva. In spite of all precations a certain amount of laceration almost always occurs in a primipara, and even when the perineal body seems intact externally there may be considerable laceration of the lower part of the posterior vaginal wall.

Sometimes the expulsion of the head is rapidly effected by a succession of violent pains, so that no opportunity occurs for controlling the mechanism. More often, and especially in the case of a primipara, a gradual advance with each pain occurs, the head retreating completely in the

intervals. Thus the vulva and perineal body are gradually stretched. Finally the head reaches a position in the outlet from which it shows little or no tendency to retreat during the interval, and it may then be maintained in that position by making pressure over the stretched perineal body, while with the other hand the stretched vulval ring is slipped back over the parietal eminences. The head will then be easily freed by pushing forward the anterior part which is still within the maternal canal.

After the expulsion of the head has taken place, a pause in the uterine contractions occurs. The child's eyes should now be wiped with pledgets of cotton-wool soaked in boric lotion, and if the cord encircles the neck it should be pulled over the occiput and freed. If the pause is a long one, the face will become cyanosed from the pressure exerted upon the undelivered trunk. As soon as the uterus contracts again, the movement of external rotation will be observed, and when the bis-acromial diameter has entered the antero-posterior of the outlet, delivery of the body may be assisted by drawing the head *gently* forwards round the symphysis and making pressure with the other hand upon the uterine fundus (Fig. 163). In case of difficulty the index finger may be hooked into the axilla of the posterior shoulder, and traction thus made upon the trunk, *in the axis of the pelvic outlet.* In order to secure proper retraction of the uterus, the hand must not leave the fundus during the delivery of the body of the child, if the body is delivered by traction.

Management of the Third Stage.—The labour has now entered upon the third stage ; the attention of the medical attendant will be given first to the condition of the uterus, and then to the division of the cord. This apparently trivial procedure should be carried out with due antiseptic precautions, the ligatures and scissors being boiled before use, and the hands properly disinfected ; it is of great importance in the prevention of umbilical sepsis in the new-born child. The cord should not be divided until the child has cried loudly, respiration is properly established, and the pulsation has nearly ceased. The child is then wrapped up in blankets and removed. The perineum should next be examined to note the degree of laceration, if any, which has occurred, and

in so doing the vulva should be opened up with clean fingers, so as to bring the posterior vaginal wall into view. The

Fig. 163.—Illustrating the Delivery of the Shoulders; the movement of Trunk Rotation has occurred, the Bis-acromial Diameter lying in the Antero-posterior of the Outlet.

patient should now lie upon her back, for in that position the uterus can be controlled much more easily and effectually

than in the side position. Nothing should be done except gently to massage the uterus until it is perceived that the placenta has been expelled from it.

At the beginning of this stage the medical attendant should on abdominal examination carefully note the height of the fundus, the size, mobility, and outline of the uterus, and the presence of the usual slight supra-pubic hollow. All these points can be observed much more easily in the dorsal than in the side position. By the changes which occur subsequently he will be able to recognise the detachment of the placenta. When separated from the uterine wall the placenta falls into the cervix or the vagina. In consequence the body of the uterus becomes smaller, harder, more globular and more movable. The level of the fundus also rises slightly, as the presence of the placenta below prevents the uterus from sinking into the pelvic cavity. For the same reason the supra-pubic hollow becomes replaced by a slight bulging, indicating the position of the placenta in the cervix. Further evidence of separation may be found in lengthening of the umbilical cord outside the vulva. When in doubt as to the position of the placenta, the uterus may be grasped and pushed gently downwards and backwards into the pelvis ; if the placenta is still attached to the uterus the cord will visibly descend with it and retreat when the pressure is withdrawn. If separated, little or no effect will be observed.

When separated the placenta can usually be delivered by a voluntary bearing-down effort on the part of the patient, aided by the medical attendant grasping the uterus and pushing it downwards and backwards in the axis of the pelvic brim. When it is certain that the placenta has left the uterus, pressure upon the fundus may be aided by gentle traction upon the umbilical cord ; this must never be done, however, while the placenta remains attached to the uterus. When the placenta appears at the vulva, it should be received in the hands and rotated so as to twist the membranes which follow it into a spiral or rope, which gradually comes to an end and slips out without any traction having been made (Fig. 164). In this way tearing of the membranes, leading to retention of a portion in the uterus, is avoided.

If after waiting for at least half an hour it is found that

the placenta still remains in the uterus, an attempt may then be made to effect its expulsion by the manipulation of Crédé, often called 'expression of the placenta.' This consists in gently rubbing the uterus so as to bring about a firm contraction, and then compressing it strongly in the grasp of one or both hands, at the same time pressing the whole organ downwards and backwards into the pelvic cavity (Fig. 165). The partially detached placenta can in this way often be squeezed out of the uterus, but certain disadvantages always attend this manœuvre—viz., (1) portions of the placenta and of the chorionic membrane may be left attached to the uterine wall, being torn away from the bulk of the after-birth ; (2) if the uterus is

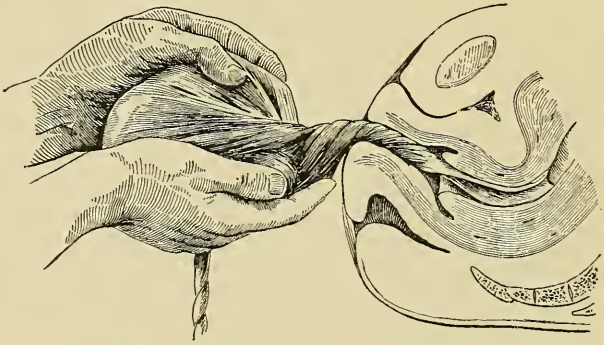


Fig. 164.—Delivery of the Membranes. (Bumm.)

thus compressed *during relaxation*, the process of inversion may be started (see p. 480). It must therefore be clearly understood that the Crédé method is not to be employed merely to save time, but only in cases where the spontaneous separation of the placenta is unduly delayed. With the aid of anæsthesia, the placenta can always be delivered by this method, unless morbidly adherent, but the risk of retention of a portion of the after-birth is naturally greater than when anæsthesia is not used.

Prolongation of the third stage, if not accompanied by considerable hæmorrhage, is not of itself disadvantageous to the patient. There is therefore no need for hurry, and it must be borne in mind that natural separation of the placenta is much to be preferred to its artificial removal, and

is worth waiting for. If the placenta has not been fully separated in half an hour from the birth of the child, an attempt may be made to deliver it by expression. Unless an undue amount of bleeding occurs, manual removal of the placenta by passing the hand into the uterus (see p. 515), should not be undertaken until at least an hour has elapsed.

After a normal labour vaginal douching is unnecessary,

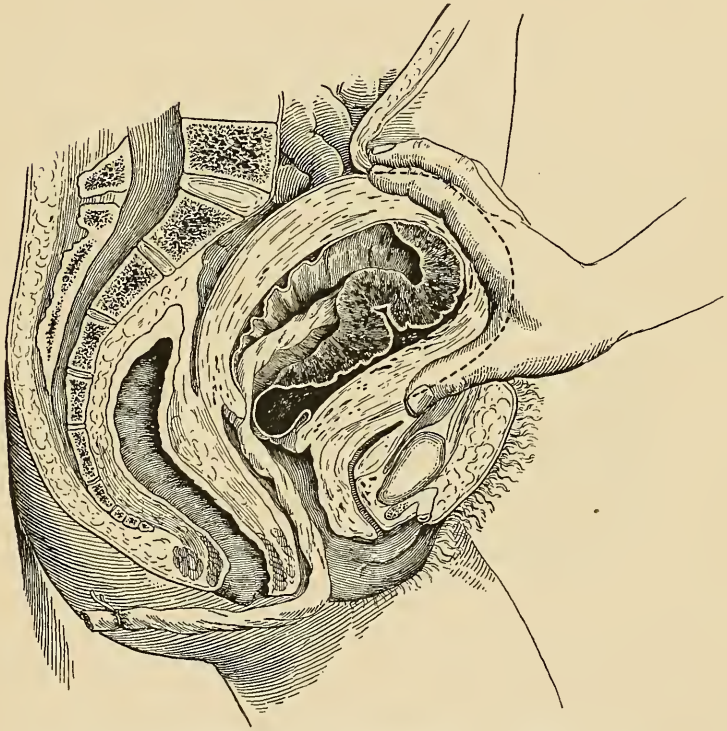


Fig. 165.—Expression of the Placenta. (After Crédé.)

but the nurse should thoroughly swab the vulva with an antiseptic solution (*e.g.*, 1–2,000 biniodide of mercury), and all perineal tears of $\frac{1}{2}$ inch or more must be immediately repaired. The uterus should be continuously massaged for ten to fifteen minutes after the delivery of the after-birth, and gently but firmly squeezed to expel any blood-clot that may have remained within it (Fig. 166). Persistence of hæmorrhage at this time is frequently due to the presence

of a clot in the uterus, and when this has been squeezed out the bleeding immediately ceases. The presence of a clot in the uterus does not always cause bleeding, but it invariably interferes with the proper retraction of the uterus. The empty, fully retracted and contracted uterus feels densely hard in consistence, and irregular in outline; when the uterus remains globular and bulky during a contraction, and softish in consistence, a clot is probably present. If a clot

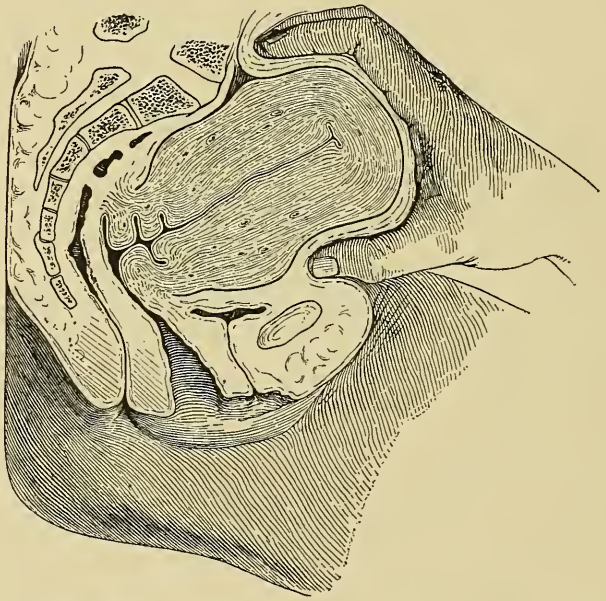


Fig. 166.—Compression of the Fundus in order to empty the Uterus after Delivery of the Placenta. (Edgar.)

is allowed to remain in the uterus, although hæmorrhage may cease, the patient is liable to (1) severe after-pains; (2) delayed involution; (3) sapræmia. Should the uterus still tend to become flabby, a dose of ergot may be given, either by the mouth in the form of liquid extract of ergot 5j, or preferably by deep intra-muscular injection into the buttocks in the form of injectio ergotinæ hypodermica (B.P.) or 'aseptic ergot.' A useful alternative to ergot is pituitary gland which may be given intra-muscularly in dose of 1 cc. of a 20 per cent. solution. These drugs are seldom

required by a primipara, but there is no objection to their routine use in multiparæ. Finally an abdominal binder should be firmly applied, and a pad of sterilised absorbent cotton or gamgee tissue, or of corrosive-sublimate wool, placed over the vulva.

Occipito-posterior Positions of the Vertex

The two posterior positions—third and fourth taken together are much less frequent than the two anterior positions—first and second, the relative proportions being about 1 posterior to 3 anterior (see p. 288).

Mechanism.—The mechanism differs from that of the anterior positions in two particulars—(1) flexion is deficient in a considerable proportion of cases ; this is due, (*a*) to a tendency in posterior positions towards extension of the spine and therefore of the head ; (*b*) to the obstacle offered by the pelvic walls to the descent of the occipital end of the head, while the sincipital end is free ; (2) the movement of internal rotation is unfavourably influenced, since either (*a*) a long movement of forward rotation, or (*b*) non-rotation, or (*c*) backward rotation must occur. If the uterus acts powerfully, flexion is good, and the head and pelvis are of normal size, the occiput will rotate forwards ; if, however, flexion is deficient, or the pains are feeble, or if the head is unusually large, or the pelvis abnormally small, the head will remain unrotated (Fig. 101), or the occiput will rotate backwards into the sacral hollow. When forward rotation occurs the case terminates in the same way as an anterior position ; but when non-rotation or backward rotation occurs serious difficulty is met with in the expulsion of the head. Fig. 167 shows that in the latter position the shoulders enter the pelvic cavity along with the head ; the vagina is consequently over-distended and the descent of the presenting part is made more difficult. The part of the head which in this case first presents at the vulva is the region of the anterior fontanelle ; the occipito-frontal diameter ($4\frac{1}{2}$ inches) is therefore engaged in the antero-posterior diameter of the outlet. The vertex first passes out beneath the symphysis pubis ; then the perineum stretches and the occiput slips over it ; finally the face passes under the symphysis, and

thus the delivery of the head is completed by a movement of extension. It will be seen that much longer diameters of the fœtal head are engaged than when the occiput is anterior. Further, the wide posterior part distends the perineum instead of emerging between the labia, and the risk of severe laceration is thus much increased.

Diagnosis and General Course of Labour.—The

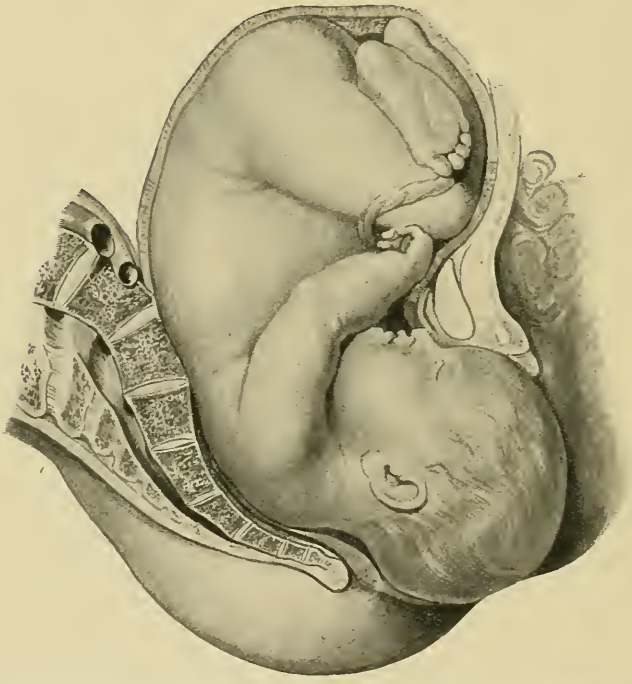


Fig. 167.—Illustrating the Difficulty in Delivery of the Head in persistent Occipito-Posterior Positions.

diagnosis of occipito-posterior positions has been already in part considered (p. 312), but the signs found on external examination may be briefly recapitulated. First, in thin subjects the abdomen may be observed to be flattened and slightly irregular, instead of convex and uniform as in anterior positions. Secondly, on palpation the limbs are felt with unusual ease, and upon both sides of the middle line. Thirdly, the back may be difficult to locate. Fourthly, the wide, irregular frontal end of the head may be felt to be

directed forwards. Fifthly, the position in which the heart-sounds are heard may also be of diagnostic importance.

Generally speaking labour is prolonged and often attended with pains of unusual severity. Both the first and second stages are prolonged, and it is probable that the uterus acts at a disadvantage when the fœtal spine is posterior and there is a consequent tendency to extension. The descent of the head is unusually difficult for the reasons just stated, and in the second stage the pains often become very severe and almost continuous, although the labour makes but very slow progress.

On internal examination during the second stage, the finger may detect the anterior fontanelle lying within easy reach, and inclined to one or other side of the pelvis. Further, a careful observer may notice that the contour of the presenting part is abnormal, as will be understood by referring to Figs. 131 and 133. In anterior positions the presenting part is uniformly convex and nearly circular in outline ; in posterior positions it is flatter and irregularly quadrilateral in outline. This results not from the posterior position, but from the accompanying deficiency of flexion. When spontaneous forward rotation occurs, the anterior fontanelle recedes out of reach and an alteration in shape of the presenting part may become quite evident, as the head has also become better flexed.

The course of the second stage must be carefully watched, and special attention paid to the descent of the head, and to signs of rotation in one or other direction. More frequent examinations are necessary than in a normal labour, and the greatest care in observing the antiseptic routine is called for. Non-rotation is usually accompanied by non-descent ; when the head begins to make progress it usually also rotates, and in the great majority of instances the rotation is forwards, not backwards. Time is always required for rotation, and consequently a prolonged second stage is to be anticipated, and any attempt to unduly hurry the conclusion of this stage is to be deprecated. Interference should be delayed until it becomes clear that spontaneous rotation will not occur, and the usual limits of this stage have been exceeded.

Management.—When a posterior position has been detected during the last weeks of pregnancy, or at the

commencement of labour, an attempt may be made to correct it by external abdominal manipulations. This is done by locating the anterior shoulder below and the breech above, and endeavouring to rotate the body of the fœtus towards the *opposite side*. If the anterior shoulder can be pushed across the middle line the position has been converted into an anterior. In a primipara this manœuvre is very difficult owing to the low level of the head ; in a multipara it is easier, for the head lies higher. If corrected before labour the posterior position may recur.

The chief object of the management of labour in occipito-posterior positions is to convert the case into an occipito-anterior. Since nine out of every ten cases end naturally in forward rotation, little need be done until it becomes evident, during the second stage, that the occiput will not come forward. The main cause of non-rotation forward is deficient flexion, and it is obvious that if the head could be fully flexed, forward rotation might occur spontaneously. The advice often given to promote flexion either by pushing up the sinciput with the fingers, or by pulling down the occiput with an instrument such as a vectis during the pains, although theoretically sound, is difficult to carry out effectually. Further it is almost always found that extension recurs, the reason being that it is associated with, and largely depends upon, extension of the spine ; and the former probably cannot be corrected, except momentarily, apart from the latter. It is, however, useful to arrange that the patient should lie upon the side which will so affect uterine obliquity as to promote flexion—the left side in the third position, the right side in the fourth position (see p. 294). To push the uterus across the middle line a thickly-folded towel may be placed at the side of the uterus and kept in position by a binder. When the second stage has lasted for two or three hours and there is no sign of forward rotation occurring, it is better to terminate the case with forceps, first rotating both the head and trunk of the child so as to bring the occiput and the back to the front.

Manual rotation is not always easy to carry out, and an anæsthetic is required in all cases, as the whole hand must be introduced into the vagina. Sterilised rubber gloves should be worn by the operator. Rotation can be performed more

easily with the patient lying on her back than in the side position ; the buttocks should be drawn over the edge of the bed and the legs supported by an assistant or held in a Clover's crutch. In the third position the operator's left hand will be most convenient for internal use, in the fourth position the right ; this will allow of the rotation being done by a movement of pronation, the fingers being passed up behind the occiput, the thumb lying in front of it.

Before attempting rotation the exact position of the head and the degree of extension should be determined ; if flexion is very deficient, an attempt should be made to bring down the occiput, either with a blade of the forceps or by passing the fingers above it up to the neck and then pulling the occiput downwards. The more the head is flexed the easier will it be to rotate it. Then the head is firmly grasped in the manner just described, and the occiput turned forwards towards the symphysis. It is desirable to rotate the trunk as well as the head, otherwise the neck will be twisted and the occiput will tend to return to its faulty position as soon as it is released from the fingers. Trunk rotation may be assisted by the operator finding the anterior shoulder with his disengaged hand and endeavouring to push it over towards the middle line, while the internal hand is rotating the head. Or in a difficult case the internal fingers may be passed upwards above the head to the anterior shoulder, which is then forcibly pushed across the middle line to the opposite side. When, however, little liquor amnii remains in the uterus, rotation of the trunk is almost impossible, and it is then best to rotate the head as much as possible, and, while the hand keeps it in its corrected position, to apply the forceps immediately, before the head can return to its faulty position. With the patient lying on her back the right blade should be first introduced when dealing with a third position, as this will effectually prevent the occiput from again rotating backwards. In the fourth position the left blade should be first applied. If manual rotation should entirely fail the forceps must be applied to the non-rotated head, but serious lacerations of the pelvic floor involving the rectum will probably occur in a primipara ; in a multipara there may be no serious injury if the head and the pelvis are of normal size.

In a multipara with feeble uterine contractions, the head may completely fail to engage in the brim ; labour advances, the cervix dilates, the membranes rupture, and no advance of the head occurs, which remains freely movable above the level of the pelvic brim. This is the most difficult example of an occipito-posterior position to deal with. The application of forceps to the head above the brim is the most difficult operation in obstetrics. In addition the head must be rotated before the forceps is applied, and rotation is

Fig. 168.—Usual Moulding in Occipito-Posterior Position. (Galabin and Blacker.)

much more troublesome with the head at this high level than when it has reached the pelvic cavity. The best method of delivery in such circumstances is internal version if the child is alive ; craniotomy may be performed if it is dead.

The *moulding* of the fœtal head in occipito-posterior positions differs somewhat from that in anterior positions (Fig. 168). The compression of the occipito frontal plane is exaggerated, and the frontal bones are more markedly displaced beneath the parietal bones. The position of the caput has been already mentioned.

Part IV

ABNORMAL LABOUR

In this section the following conditions will be considered:

(I.) *Abnormal Presentations.*
- Face and brow presentations.
- Breech or pelvic presentations.
- Transverse or shoulder presentations.
- Twin labour.
- Prolapse of the cord and limbs.

(II.) *Abnormal Conditions of the Maternal Passages.*

(*a*) *The bony pelvis.*
- Pelvic contraction.
- Tumours of the pelvic bones.

(*b*) *The soft parts.*
- Ovarian tumours.
- Uterine tumours.
- Rigidity of the cervix.
- Rigidity of the pelvic floor.

(III.) *Abnormalities in the Action of the Uterus.*
- Precipitate labour.
- Uterine inertia.
- Tonic uterine contraction.
- Ante-partum rupture of the membranes.

(IV.) *Obstructed Labour.*

(V.) *Maternal Injuries in Parturition.*
- Rupture of the uterus.
- ,, ,, ,, cervix and vagina.
- ,, ,, ,, perineum and vulva.
- Hæmatoma.
- Inversion of the uterus.

(VI.) *Ante-partum Hœmorrhage.*

(VII.) *Non-expulsion of the Placenta.*

(VIII.) *Post-partum Hœmorrhage.*

(IX.) *Labour complicated by Eclampsia.*

Face and Brow Presentations

These presentations are brought about by complete extension of the head upon the spinal column, the occiput resting against the cervical vertebræ, and the chin being widely separated from the chest wall (Fig. 169). They occur in about 1 in 300 labours (0·3 per cent. Queen Charlotte's Hospital statistics). Little is known of the causes of this complete extension of the head, but it is believed that the following may be either essential or contributory causes :

1. Extreme obliquity of the uterus.
2. Pelvic contraction.
3. Large size of the fœtus.
4. Dolicho-cephalic fœtal skull (long antero-posterior diameters).
5. Congenital malformations—*e.g.* goitre and anencephaly.
6. Multiparity.
7. Placenta prævia and hydramnios.

Face Presentation.—This presentation is very rarely met with in *pregnancy*, but appears to be usually produced at the onset of labour, by conditions which prevent the easy entrance of the vertex into the pelvic brim. Causes 1, 2, and 3 therefore need no comment ; the influence of uterine obliquity in causing extension of the head has been referred to on p. 294. Considerable doubt exists whether the elongation of the antero-posterior diameters of the fœtal head, which is often met with in face cases, is primary or secondary, many observers maintaining that it is produced during labour, and is therefore the effect, not the cause, of the presentation. The congenital malformations mentioned have been responsible for the very rare instances in which face presentation has been recognised before labour. Congenital goitre is not uncommon in countries where goitre is endemic, but elsewhere it is extremely rare. Face presentation results from the mechanical obstacle to flexion, and is really an advantage, since it protects the gland from injurious pressure from the chin. The anencephalic head lies naturally in full extension. Statistics show that this presentation occurs in primigravidæ and multiparæ respectively in the proportion of two to three, and repeated presentation of the face has

been observed in successive labours in the same patient. Placenta prævia and hydramnios favour all kinds of abnormal presentation, but not especially that of the face.

The *attitude* of the fœtus is shown in Fig. 169. It will be noticed that, while the limbs are flexed, the trunk and spine are extended ; the outline of the back is flat, not convex, and is broken below by the prominence formed by the occiput when the head is completely extended. The interval seen between the knees and elbows is of course caused by the

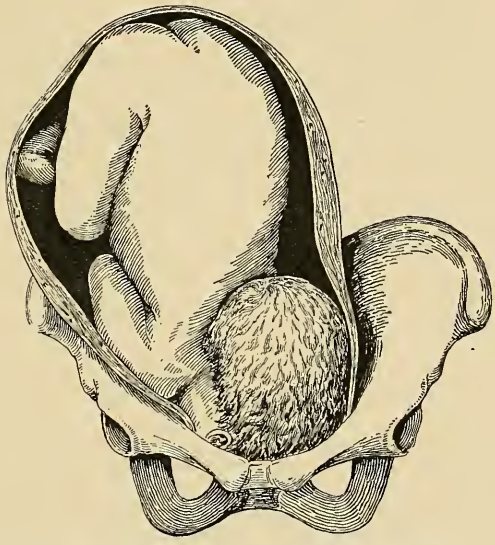


Fig. 169.—Face Presentation : First Position.
(Ribemont-Dessaignes and Lepage.)

extension of the spine. Four *positions* are distinguished as follows, the chin being the denominator of the presentation :

1st position	.	Right mento-posterior	. R.M.P.
2nd ,,	.	Left mento-posterior	. L.M.P.
3rd ,,	.	Left mento-anterior .	. L.M.A.
4th ,,	:	Right mento-anterior	. R.M.A.

The first position is by far the commonest, then comes the third ; the second and fourth are rare. The face therefore engages in the right oblique diameter of the brim in a very large preponderance of cases, just as does the vertex. The relation of the head to the pelvis at the commencement of labour is shown in Figs. 169 and 170. By comparison with

Figs. 131 and 132 it will be seen that the presenting part occupies a comparatively small part of the pelvic space. In

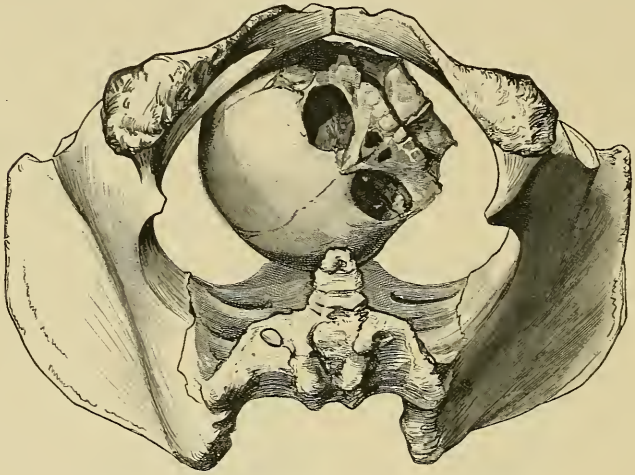


Fig. 170.—Face Presentation: Third Position.

comparing the positions of the face with those of the vertex, it will be observed that they precisely correspond in respect

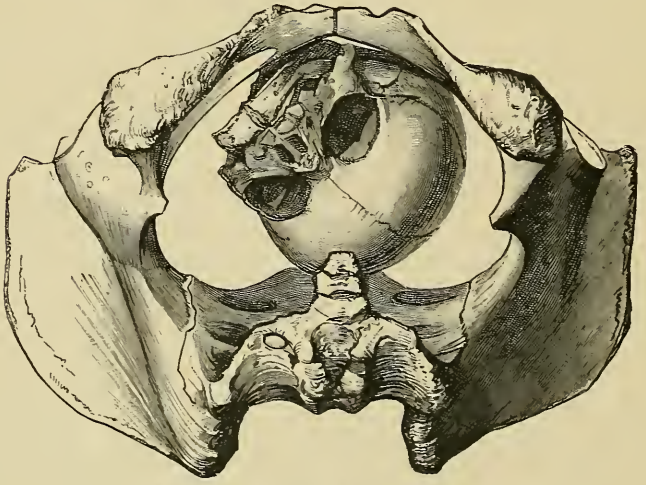


Fig. 171.—Face Presentation: Fourth Position.

of the position of the back of the fœtus; in the first and second positions it is anterior, in the third and fourth

posterior, in both presentations. Thus, if in a first vertex position the head became completely extended, a first position of the face would result from it.

Diagnosis.—Abdominal palpation should be carried out in the systematic manner described in connection with normal labour. The actual shape of the fœtal ovoid will attract attention if the back is anterior (Fig. 169); the head in this case will lie well above the pelvic brim at the commencement of labour, even in a primipara, and the prominent occiput, with the sulcus between it and the back, can be palpated. It is not nearly so easy to make out the entire surface of the back as in a vertex presentation, for a considerable interval exists between the upper dorsal region of the back and the maternal abdominal wall. In palpating from the fundus downwards, the outline of the back is therefore lost before the occipital prominence is reached. When the back is posterior, the prominent occiput is not readily accessible to palpation; but the small parts representing the limbs are extremely easily felt. The two most important points on palpation therefore are the indistinct outline of the back and the deep sulcus between the occiput and the cervical spine. *Auscultation* affords little help in diagnosis; the heart is heard at a somewhat higher level than, but otherwise in the same position as, in vertex presentations; and in anterior positions of the chin the sounds are unusually distinct, as the chest is thrown forwards against the abdominal wall.

Vaginal examination at the commencement of labour is indecisive; the presenting part lies high and is ill-defined in outline; it will often be impossible to distinguish it from the breech. When the first stage is more advanced, the bag of waters will be noticed to be unusually large, and premature rupture of the membranes is fairly common. The large size of the bag is due to the fact that, as the face does not fill the lower segment so well as does the vertex, a larger amount of liquor amnii descends below the presenting part. Great care should be taken not to rupture the membranes accidentally, but during the intervals between the pains it will probably be possible by gentle touch to recognise (*e.g.* in the third position) the frontal suture leading anteriorly to the orbital ridges and to the nose (Fig. 170). At a still later

stage, when extension of the head has become complete and the cervix is further dilated, it will be found that the orbital ridges, mouth, and chin can all be reached and recognised by the finger. The direction of the chin will of course indicate which of the four *positions* of the face is present (see Figs. 172 and 173). During the second stage diagnosis by vaginal examination may become very difficult owing to the tumefaction of the brow, cheeks, and lips (caput succedaneum), which results from pressure around the girdle of contact.

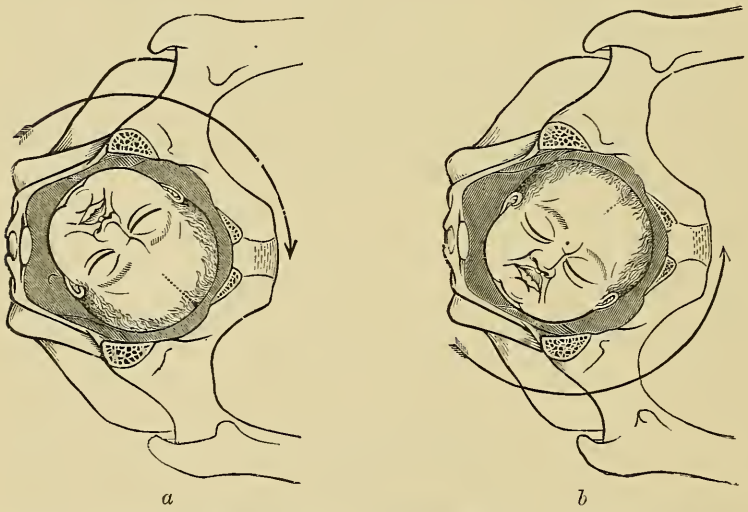


FIG. 172.—Face Presentation. *a*. First Position. *b*. Second Position. (Farabœuf and Varnier.)

The arrow indicates the line of forward rotation. Patient in usual obstetric position.

The orbital ridges become obscured and the mouth opens, but by passing the finger into the mouth the *alveolar processes* can always be recognised, and this is accordingly a most important diagnostic point. The nose undergoes little alteration, and consequently the nares with the septum between them may still be recognisable (Fig. 178) when the other parts have become completely obscured by swelling.

Mechanism.—(1) Extension in a face presentation corresponds with flexion in a vertex. It is produced at the onset of labour by the conditions named above, and is progressive, being frequently incomplete until the head has

descended well into the pelvic cavity (Fig. 174). When completely extended the diameter of engagement is the sub-mento-bregmatic ($3\frac{3}{4}$ inches), which lies in one of the oblique diameters of the brim ($4\frac{3}{4}$ inches); when incompletely extended a longer diameter, the sub-mento-vertical ($4\frac{1}{2}$ inches), becomes engaged. The greatest transverse diameter of the face (bi-malar) is considerably less than that of the vertex, the bi-parietal. There is thus no difference

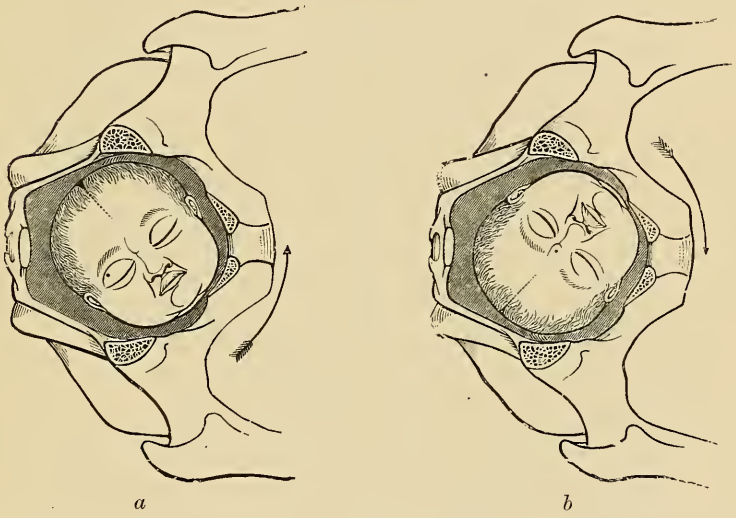


FIG. 173.—Face Presentation. *a*. Third Position. *b*. Fourth Position. (Farabœuf and Varnier.)

The arrow indicates the line of forward rotation. Patient in usual obstetric position.

between a fully-flexed vertex and a fully-extended face in the length of the diameter of engagement, while the transverse diameter is smaller; but it must be remembered that while the size of the vertex may be reduced by moulding, the bones of the face are incompressible. Deficient extension influences a face presentation unfavourably by introducing a longer diameter of engagement.

(2) *Internal rotation* is probably controlled entirely by the slope of the pelvic floor; when the head is completely extended the chin is the lowest part, and therefore it first reaches the pelvic floor and is directed by the slope down-

wards and forwards under the pubic arch. Since the most frequent position is the right mento-posterior, this usually involves a long movement of rotation (about $\frac{3}{8}$ths of a circle)

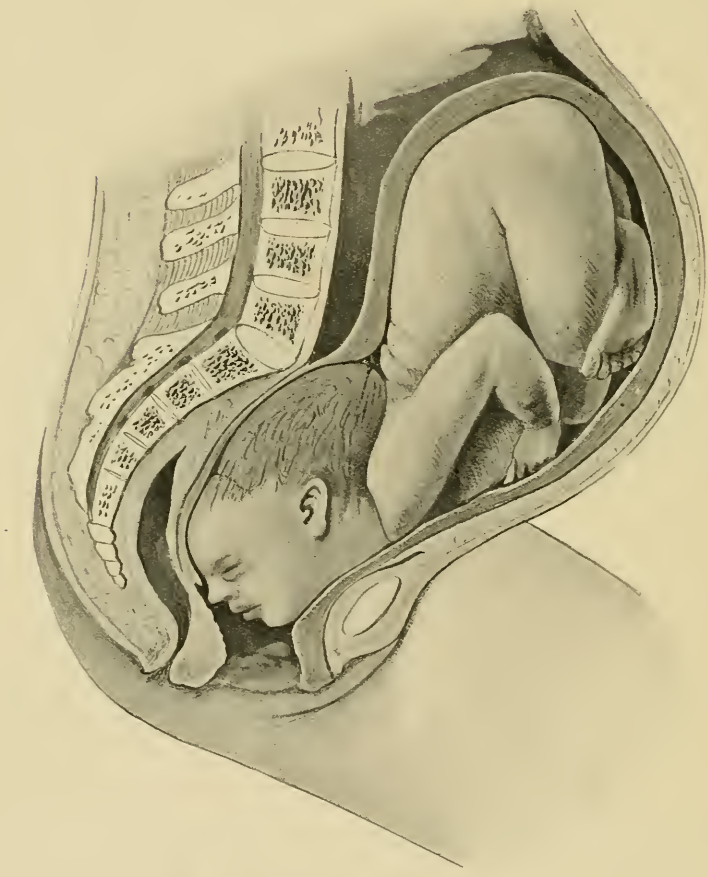


Fig. 174.—Face Presentation : Third Position. The completely extended face has descended into the pelvic cavity, and still lies in the right oblique diameter. The head is elongated antero-posteriorly.

around the right wall of the pelvis. If the head is imperfectly extended so that the sinciput is lower than the chin, the latter will rotate backwards into the sacral hollow (*persistent mento-posterior position*). Natural delivery is then im-

possible, except in the case of a very small or macerated fœtus.

(3) *Flexion.*—After forward rotation of the chin has occurred, the head becomes disengaged by a movement of flexion, which thus takes the place of extension in a vertex

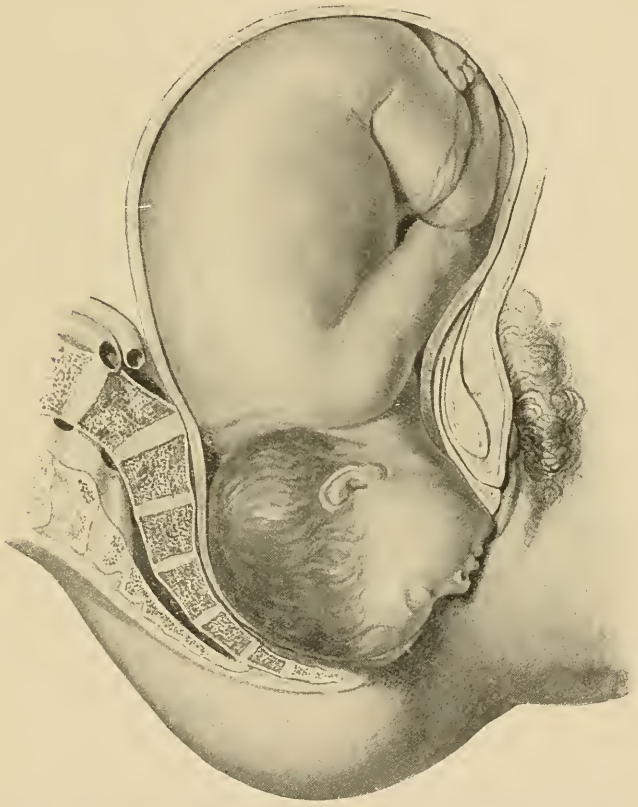


Fig. 175.—Face Presentation. Forward Rotation of the Chin has occurred.

presentation. The chin first emerges under the symphysis pubis; then the face, forehead, vertex, and lastly the occiput pass successively over the perineum (Fig. 176). It is important that the chin should be brought well forwards under the pubic arch before flexion occurs, otherwise the mento-vertical diameter ($5\frac{1}{2}$ inches) must pass through the outlet instead of the sub-mento-vertical ($4\frac{1}{2}$ inches). It is

therefore clear that the passage of the head through the vulva in a face presentation is always more difficult than in a vertex presentation, owing to the greater length of the diameters of engagement.

(4) *Restitution* and *External rotation* are brought about by

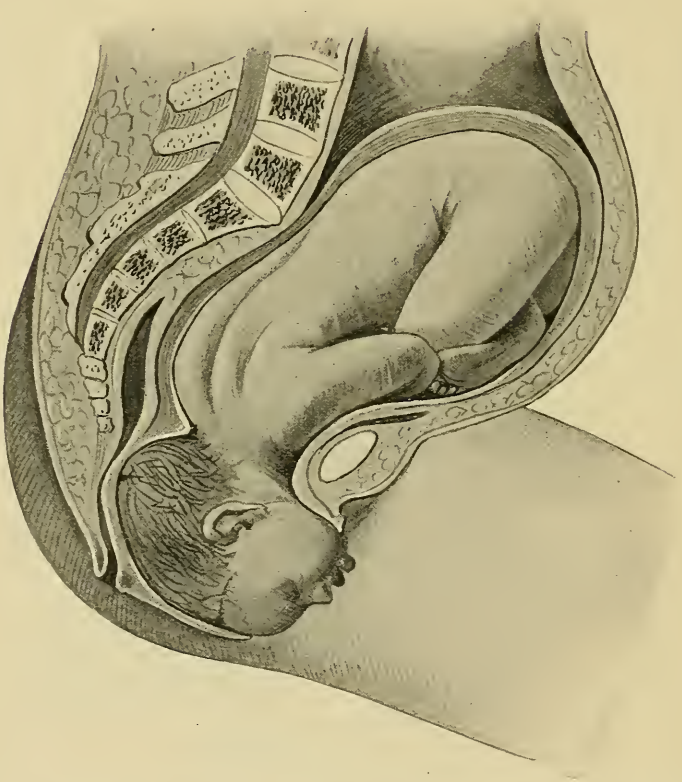


Fig. 176.—Face Presentation. The movement of internal rotation has occurred, and the face is passing through the outlet by a movement of flexion.

the same causes, and follow the same rule with regard to direction, as in vertex presentations.

The most favourable positions in presentation of the face are those in which the chin is anterior (third and fourth). In these the back is posterior, and the effect of its apposition with the maternal vertebral column is to extend the spine, and thus promote extension of the head—the normal

mechanism of this presentation. In addition, the movement of forward rotation of the chin is much shorter than in the first and second positions.

The effects of labour upon the head of the fœtus are very marked. The tumefaction of the face has been already referred to ; it is, of course, due to the formation of the caput succedaneum, but in this case the effusion is usually sanguinolent, giving the appearance of considerable bruising, often accompanied with small bullæ containing blood-stained fluid. The effusion, as a rule, becomes absorbed in

Fig. 177.—Moulding of the Head after Face Presentation. (After Budin.)

a few days after birth, and the skin rapidly regains its normal colour. The changes produced during labour in the shape of the skull are also shown in Fig. 177. The vertex becomes flattened by being compressed against the pelvic wall, thus reducing the sub-occipito-bregmatic and sub-mento-bregmatic diameters, while the occipito-frontal diameter becomes considerably lengthened, the plane of principal compression being the plane of the sub-mento-bregmatic diameter.

The mechanism of labour in a face presentation may be said to differ from that in a vertex mainly in the greater difficulty of the expulsion of the head and the more serious

results of backward rotation. A face presentation, as a rule, brings no more risk to the mother than a vertex ; labour is, however, longer, because the face is a less efficient dilator and the membranes are more liable to rupture early ; further, as repeated examinations may be necessary for diagnosis, the strictest antiseptic precautions are called for. There is some increase of risk to the child, owing mainly to the comparative frequency of such complications as premature

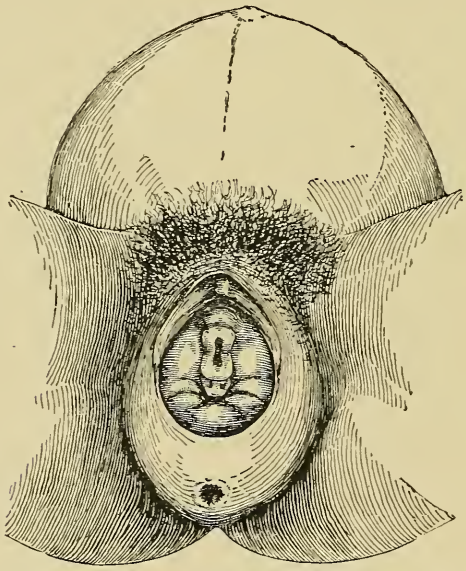


Fig. 178.—Delivery of the Head in Face Presentation: Movement of Flexion. (Ribemont-Dessaignes and Lepage.)

The swelling of the lips and the unaltered condition of the nares are shown.

rupture of the membranes, and prolapse of the cord or of one of the hands.

Management of Face Presentations.—The possibility of the pelvis being contracted should always be borne in mind in connection with face presentations. Since the majority of cases terminate naturally by forward rotation of the chin and spontaneous disengagement of the head, interference is not always called for. It is therefore the wisest plan to leave face presentations alone, and interfere only under certain well-defined conditions. The membranes

should be very carefully preserved, for the face is an inefficient dilator ; therefore vaginal examinations should be made with special care, and the patient kept lying down during the greater part of the first stage. During the second stage what is possible should be done to promote extension ; forward rotation of the chin will then inevitably follow. Use may be made of uterine obliquity in promoting extension by directing the patient to lie upon the side opposite to that on which the chin has been located ; but upward pressure with the fingers on the forehead or downward traction on the chin, if attempted, must be applied very carefully, as the face may be seriously injured or the eyes infected. If the chin rotates backwards, or if forward rotation is much delayed, the best treatment is to anæsthetise the patient, and then rotate the head and trunk so as to bring the chin forwards, in the manner already described in connection with posterior positions of the vertex (p. 340). The chin should then be pulled down until the face is completely extended, and the head immediately delivered with forceps. If forward rotation cannot be accomplished in this way, it may prove possible to deliver with axis-traction forceps in the case of a small fœtus, even in the persistent mento-posterior position. If, however, this should fail, craniotomy will probably be required.

Fig. 179.—Face Presentation : the Head of the Child after Delivery. (Ribemont-Dessaignes and Lepage.)

If the presentation is complicated by prolapse of the cord or of a hand, the best treatment is to perform version by either the combined or the internal method (p. 675) ; the object of this interference is to obviate the increased fœtal risks of these complications.

It has been sometimes advised when a face presentation

is recognised early in labour, before rupture of the membranes, that an attempt should be made to convert it into a vertex by flexing the head. It may be said that this procedure is unnecessary, difficult to carry out, and if not completely successful it does harm by bringing about the most unfavourable of all cephalic presentations—viz., the *brow*. The essential difficulty is that both the spine and the head must be flexed, or the face presentation will immediately recur. Many methods of attempting this correction have been described by Baudelocque, Schatz, Thorn, and others, but it may be said that they are only suitable for the practice of lying-in hospitals, and cannot be recommended for general adoption. As a routine principle face presentations should be left to nature unless the conditions exist which, as has been mentioned, call for the performance of version. When face presentation occurs with a contracted pelvis, the management of the labour will be governed mainly by the shape and size of the pelvis.

Brow Presentations.—When the head lies midway between the attitude of complete flexion and that of complete extension, the brow presents at the brim, and the longest diameter of the head (mento-vertical, $5\frac{1}{2}$ inches) becomes the diameter of engagement. The shape and size of the mento-vertical plane, as shown in Fig. 180, make the passage of the normal-sized head through the pelvis, when presenting in this way, well-nigh impossible. Probably this presentation should be regarded as a sub-variety of the face presentation, due to arrest midway of the process of extension.

Diagnosis.—Presentation of the brow usually passes unrecognised until labour is well advanced. The external examination may show nothing abnormal, while vaginally the presentation will be mistaken for a vertex until the cervix is well dilated. The brow presentation may then be recognised by the presence of the anterior fontanelle at one end of the presenting part and the orbital ridges at the other. When the mouth and chin can be felt, the presentation is a face. It is fortunate that this presentation is rare (1 in 1,500 to 2,000 labours), for natural delivery is impossible unless the fœtus is undersized.

Mechanism.—The orbital ridges may be either anterior or posterior in brow presentations, the former being the more

favourable. An anterior brow may be delivered naturally if the head is small, the pelvis is of normal size, and the uterus is acting powerfully. Moulding then occurs, which results in marked compression of the mento-vertical diameter, and compensating elongation of the occipito-frontal ; this causes great bulging of the frontal bones. The head then descends with the superior maxilla compressed against the pubes, the occiput lying in the sacral hollow ; the frontal region first appears at the vulva, and is followed by the vertex and occiput, the face and chin being disengaged from the pubes the last of all. This method accordingly resembles the delivery of the vertex in face to pubes cases as shown in Fig. 167, but in the case of the brow presentation the head is, of course, more extended. Very considerable deformity of the head, consisting of flattening of the vertex and bulging of the forehead, results. In posterior positions of the brow, forward rotation may occur, when the case ends in the manner just described ; if rotation does not occur natural delivery is impossible.

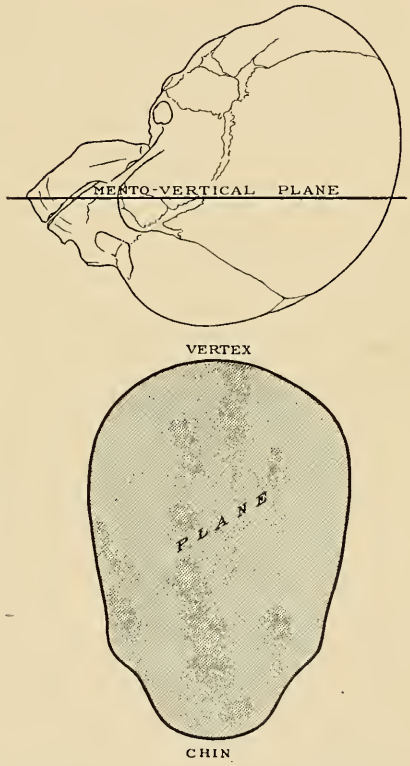


Fig. 180.—The Position and Shape of the Mento-vertical Plane. (Edgar.)

Management.—It is probable that every face presentation passes through the preliminary stage of a brow presentation; cases are accordingly observed to undergo spontaneous transformation to a face. The persistence of brow presentation, however, involves considerable risk both to mother and

child ; therefore, if detected early in labour, either before or soon after rupture of the membranes, version should be performed, and the case converted into a breech. If labour is too advanced for version to be performed, an attempt may be made either to flex the head, producing a vertex presentation, or to extend it completely, producing a face ; the latter is easier to perform, but great care must be taken not to injure the face or eyes. If the head is *fixed* in the brim, it must be allowed to continue as a brow presentation, and an attempt made to deliver with forceps as soon as the cervix is sufficiently dilated, but version in all cases offers the safest method of dealing with brow presentations.

Breech or Pelvic Presentations

When the pelvic extremity of the fœtal ovoid lies at the brim, and the cephalic extremity at the fundus, the presentation is called a *breech*. If the normal attitude of flexion is unaltered the presenting part will consist of the buttocks with the external genital organs, and one or both feet, the latter lying somewhat above the former ; this is called the *complete breech* (Fig. 181). Some alteration of the normal attitude is, however, not uncommon. The most frequent is extension of the legs upon the thighs, bringing the feet up to the sides of the neck ; this is called the *incomplete breech with extension of the legs* (Fig. 182). Sometimes, however, the thighs are extended and the legs flexed, bringing the knees down into the brim ; or, finally, both the legs and the thighs may be partially extended, bringing down the feet. The two latter are often termed *knee* and *footling presentations*, but they must of course be regarded, not as distinct from, but as varieties of, the incomplete breech presentation. Breech presentations may therefore be classified thus :

A. Complete Breech Presentation.
B. Incomplete Breech Presentation.
  (1) With extended legs.
  (2) With extended thighs.
    (*a*) Knee (legs flexed).
    (*b*) Footling (legs extended).

Occurrence.—Breech presentations occur approximately in 1 in 30 (3·3 per cent.) of all labours; if, however, premature labours are excluded, the proportion falls to 1 in 60, showing that this presentation is much more frequent in premature than in full-time labours. It is usually stated that breech presentations occur somewhat more frequently in multiparæ than in primigravidæ, but recent statistics from the Clinique Baudelocque (Paris) show that, excluding cases of contracted pelvis and of premature labour, the preponderance lies decidedly with primigravidæ. The incomplete

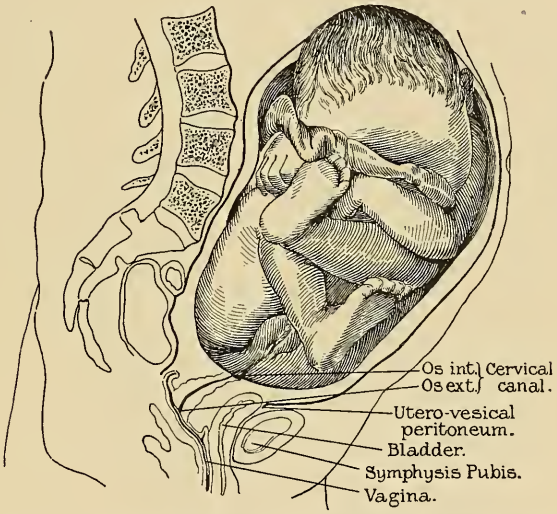


Fig. 181.—Complete Breech Presentation before Labour. From a Frozen Section. (Waldeyer.)

breech presentation, in one or other of its forms, is commoner than the complete.

Causes.—It is customary to ascribe breech presentation to disturbance of the conditions which produce vertex presentation (see p. 286). Thus the cephalic end of the fœtal ovoid may be larger than the pelvic end, as in *hydrocephalus*; the lower uterine segment may be unduly distended, and approximately equal in size to the fundus, as in *hydramnios*; the centre of gravity of the *premature fœtus* lies near the centre of the body, and therefore the tendency to lie head

downward in the liquor amnii is lost in premature labours. In addition, *placenta prævia* favours the occurrence of breech presentation, for the presence of the placenta in the lower uterine segment diminishes the capacity of this part of the uterus, and so tends to displace the head when presenting.

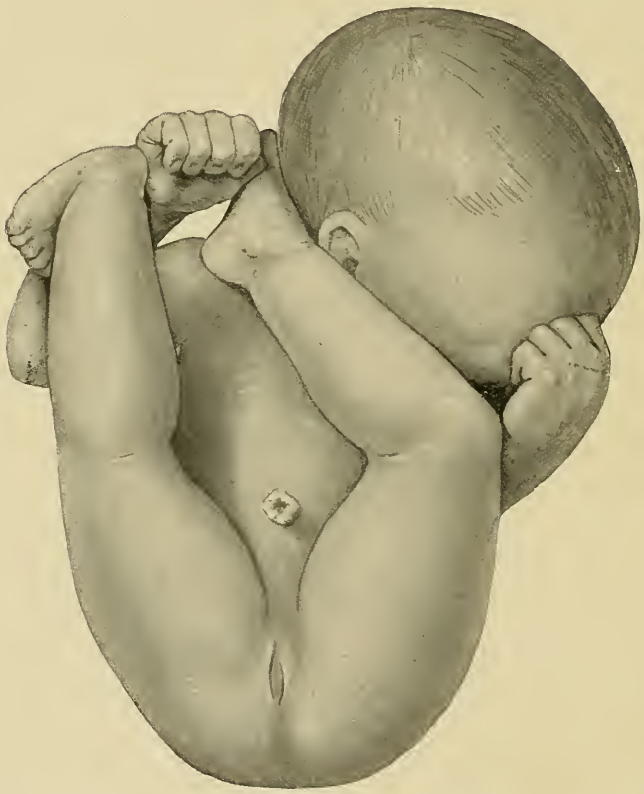


Fig. 182.—Breech Presentation with Extended Legs. From a Frozen Section. (Barbour.)

Pelvic contraction produces much the same result. It must, however, be admitted that many breech presentations occur in which none of these conditions are present, and they must therefore be regarded as merely contributory causes.

Four positions of the breech presentation are described, the sacrum being the denominator :

1st position .	Left sacro-anterior .	L.S.A. (Fig. 183).
2nd ,, .	Right sacro-anterior .	R.S.A.
3rd ,, .	Right sacro-posterior .	R.S.P.
4th ,, .	Left sacro-posterior .	L.S.P.

Diagnosis.—Abdominal palpation should be carried out in the usual systematic manner described. It is much easier to recognise a breech presentation by abdominal than by vaginal examination in the earlier stages of labour. The pelvic grip will show that the fœtal pole which occupies the lower part of the uterus does not possess the characteristics of the

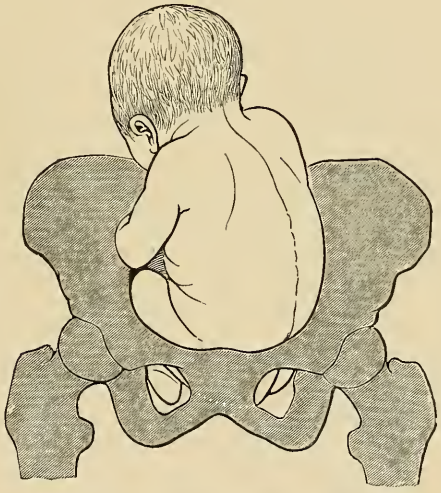


Fig. 183.—Breech Presentation: First Position. (Farabœuf and Varnier.)

head; it is softer, more irregular, and less defined in outline; it usually lies above the level of the brim, and small parts moving spontaneously may be felt near it. The fundus must next be palpated with great care, when the head will be recognised by the points mentioned on p. 314. It will usually be found, not in the middle line, but at one or other side of the fundus. It is easier to palpate its general outline than when the head lies at the brim; owing to the greater capacity of the uterine cavity at the fundus the head is freely movable upon the occipito-atloid articulation.

Back and limbs will be found in the same way as with vertex presentations. In the incomplete breech presenta-

tion with extended legs the feet lie close to the head and may be felt there *per abdomen* (Fig. 182); care will then be necessary to avoid the error of concluding that the breech lies at the fundus because small parts are found near it. The *heart-sounds* will be heard at about the level of, or a little above the umbilicus—*i.e.*, somewhat higher than in vertex presentations, but in much the same relative position as regards the middle line (Fig. 157). In the first breech position the heart-sounds are unusually loud, owing to the

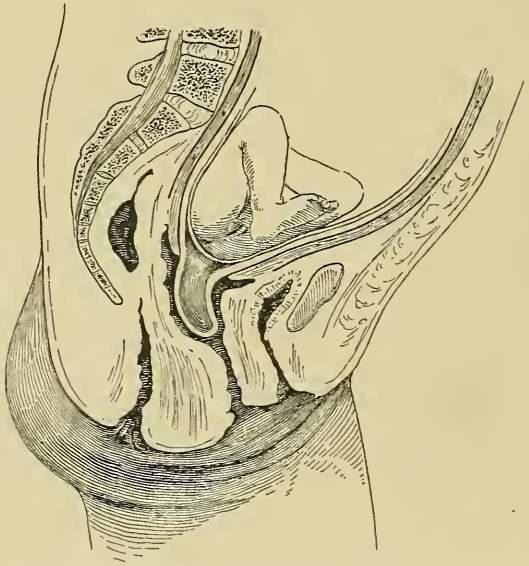


FIG. 184.—Shape of the Bag of Waters in a Premature Breech Labour. (Modified from Ribemont-Dessaignes and Lepage.)

fact that the back of the left shoulder is in close contact with the abdominal wall, a little to the left of the umbilicus (Fig. 181).

Vaginal examination early in labour will show that the presenting part lies high and cannot easily be defined; the cervix dilates slowly and the bag of waters becomes unusually elongated, assuming a sausage shape, which is fairly characteristic of this presentation (Fig. 184). This alteration in the shape of the bag of waters results from the small size of the presenting part allowing an unusually large amount of liquor amnii to descend below it, thus elongating

the membranes. Sometimes the presence of a small part (foot) can be detected in the bag of waters. Details of the presenting part cannot definitely be made out until the cervix is one-half dilated or the membranes have ruptured; but at this stage the examining finger will first come into contact with the anterior buttock—smooth, soft, and round in outline, and much smaller than the head. Exploring further, the anus will be found, and beyond it again the coccyx and lower sacral vertebræ, the latter being recognisable by their row of small spinous processes. On the side of the pelvis opposite to that occupied by the sacrum one or both feet may be found (Fig. 185), and the finger may be passed into the cleft of the groin between the flexed thigh and the abdominal wall. The male external genital organs may also be recognised and the sex thus determined. The presence of meconium on the examining finger which has been passed into the anus is of course pathognomonic of this presentation. The localisation of the sacrum is of considerable importance, for by it the *position* can be recognised. In the first and fourth positions it lies to the left, and either in front or behind respectively; in the second and third positions it lies to the right, and either in front or behind respectively. The diagnosis of position in breech presentations is not so important as in presentations of the vertex or face.

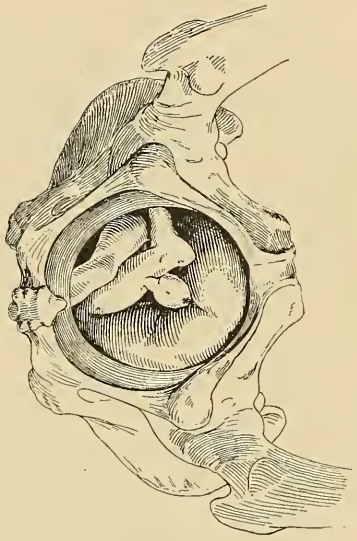


Fig. 185.—Breech Presentation: First Position.
(Ribemont-Dessaignes and Lepage.)
Patient in usual obstetric position.

The incomplete breech with extended legs is not easily recognised as such either by vaginal or abdominal examination when the presenting part is still in the pelvic brim; when the breech has passed into the pelvic cavity, the fact that the feet are not within reach of the fingers may indicate

this variety. The incomplete breech with extended thighs (knee or footling) is easily recognised on account of the small size of the presenting parts ; the foot may be mistaken for the hand before rupture of the membranes, but afterwards the foot can always be distinguished by the heel, the firm round knob being quite unlike any part of the hand.

Mechanism.—The diameter of engagement is in all cases the bi-trochanteric or bis-iliac (both 4 inches), which enters the brim in one or other oblique diameter ($4\frac{3}{4}$ inches). It

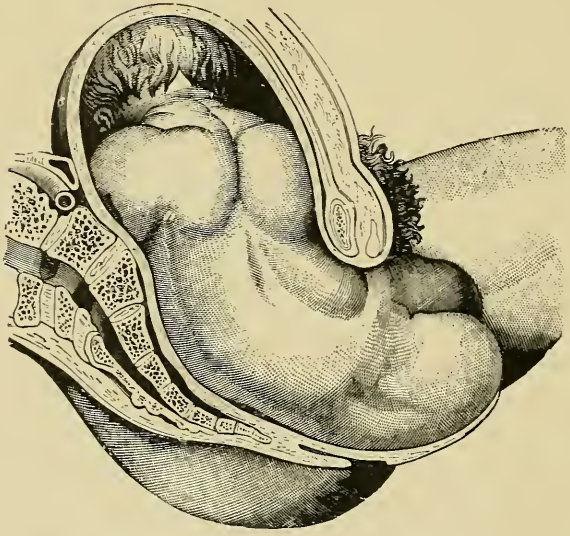


Fig. 186.—Birth of the Hips in Breech Presentation, showing Lateral Flexion of the Spine. The position is *second*, the shoulders engaging in the right oblique diameter.

will be observed that the positions correspond, as regards the direction of the back of the fœtus, with those of the vertex and face.

During the process of labour a movement of *internal rotation* occurs, affecting successively the breech, the shoulders, and the head. As the breech descends, the bi-trochanteric diameter passes from the oblique of the brim (left in the first position) into the antero-posterior of the outlet, the anterior hip coming round under the symphysis pubis. The breech is then born by a movement of descent with lateral flexion of the spine around the pubes (Fig. 186).

The anterior hip is first disengaged ; the posterior distends the perineum and follows it. At this stage the shoulders (bis-acromial diameter, $4\frac{3}{4}$ inches) engage in the same oblique diameter of the brim (left in the first position) as the breech, and in passing through the cavity internal rotation occurs, bringing the anterior shoulder under the symphysis pubis ; the trunk is born with the arms folded across the chest. While the hips lie in the antero-posterior diameter of the outlet, and the shoulders lie at the same time in the oblique diameter of the brim, a slight amount of rotation of the dorsal spine must of course occur. The head should enter the brim fully flexed, while the shoulders are passing through the outlet ; the sub-occipito-bregmatic diameter will then correspond with the right oblique, and forward rotation of the occiput follows, the anterior shoulder turning to the right side of the mother (first position). The head now lies with the nape of the neck behind the pubes, the forehead in the sacral hollow, and the face upon the pelvic floor ; it becomes disengaged by the chin, face, and forehead successively passing over the perineum, thus maintaining the flexed position to the end. Backward rotation of the occiput is practically unknown in breech labour except when the fœtus is very small, or as the result of extension of the head from some kind of interference or from want of pelvic space. In the posterior positions of the breech (third and fourth), the mechanism of labour differs little from that of the anterior positions (first and second). Owing to the apposition of the vertebral column of the fœtus to the maternal spine, the attitude of flexion is more difficult to maintain, and the occurrence of extension of the after-coming head is therefore more frequent. Internal rotation of the head is a long movement (three-eighths of a circle) as the head enters the brim with the occiput posterior ; if, however, flexion is complete, little difficulty is to be anticipated from the greater length of this movement.

Owing to their greater size, the delivery of the shoulders is more difficult than that of the breech ; the delivery of the head is more difficult than either, not because of the length of its diameters, but because it is less compressible than the breech or the shoulders, and because there is no time for moulding to occur.

The head is but little altered by breech labour. Of course no *caput* forms upon it, and there is practically no moulding. The general shape is therefore distinctly more globular than after a vertex presentation.

Anomalies in the Mechanism.—(1) Premature rupture of the membranes, with consequent loss of the dilating effect of the bag of waters, frequently occurs. (2) Extension of the legs may occur, either before labour as an abnormal attitude, or during labour from some obstacle to the descent of the complete breech. A breech labour is prolonged and difficult when extension of the legs occurs. This may be explained by the conditions present. Thus the extended legs act as splints to the trunk, tending to straighten it and to oppose the natural attitude of flexion. Further, the lateral flexion of the spine, which usually occurs during delivery of the trunk, is also prevented. Again, the later stages of labour will be impeded by the fact that the head and the feet enter the brim together. (3) One or both arms may become displaced (extended) during the passage of the trunk through the pelvis ; the displaced limb then lies either at the side of, behind, or in front of the head, and forms an insuperable obstacle to spontaneous delivery. (4) Non-rotation either of the shoulders or of the head may also occur, and delivery in the oblique diameter of the outlet will then be very difficult. (5) Finally, backward rotation of the occiput may occur spontaneously with a very small fœtus. Disengagement is then possible in one of two ways : if the head is completely flexed, the face, forehead, and vertex will pass successively under the symphysis ; if extended, the chin becomes fixed against the pubes, the occiput is disengaged first, and is followed successively by the vertex and face, the chin coming last of all.

Prognosis.—The duration of labour is somewhat longer in breech than in vertex presentations, especially in primiparæ ; this involves in itself a slightly increased risk to both mother and child. Unless artificial aid in extraction is required, the maternal risks are not otherwise increased ; interference of course increases the risks both of laceration and of sepsis.

The risks to the child are, however, decidedly greater than in vertex cases, and recent statistics estimate the fœtal

mortality *in labour* at 1 in 9 (primiparæ) to 1 in 30 (multiparæ). Older statistics might be quoted in which the fœtal mortality was about 25 per cent. In addition many infants born alive succumb within forty-eight hours to injuries received during labour. Certain fœtal risks are almost unavoidable, such as (*a*) compression of the cord during delivery of the head, (*b*) premature attempts at respiration from stimulation of the respiratory centre before the head is born. In addition it has been shown by Spencer, that serious injuries to the abdominal and thoracic viscera from compression of the trunk may often be found on post-mortem examination of infants that have died during or soon after breech delivery. And further, from traction on the limbs and shoulders, rupture of muscular fibres, fracture of bones, and injury to nerve trunks may occur. Such accidents as prolapse of the cord or premature rupture of the membranes are frequently met with, and further increase the risks to the child.

Management.—When a breech presentation is discovered during the last four weeks of pregnancy, or very early in labour, it may be converted into a vertex by *external version* (p. 671); this should always be done if the patient is a primigravida, or if the pelvis is small and of the generally contracted type (p. 395). In a multipara with a normal pelvis, correction of the presentation is not of such great importance, but should be performed in the interests of the child. It must be recollected that after correction the unfavourable presentation is apt to recur, and repeated examination should accordingly be made. Wearing a tight binder is of some assistance in maintaining the corrected position.

During the *first* stage of labour especial care is necessary to preserve the bag of waters; when this has ruptured, an examination should immediately be made to confirm diagnosis and to look out for prolapse of the cord. Untimely interference, such as extraction of the breech before the cervix is fully dilated, will lead to great difficulty in extracting the head. It is therefore of special importance to avoid interfering too soon. Even during the *second* stage nothing whatever should be done, when labour progresses favourably, until the buttocks have been completely expelled from the

vulva. The work of the medical attendant then begins, and the survival of the child will often depend upon his knowledge of what is required, and of how to do it. The legs should be gently disengaged by seizing the feet and extending first one

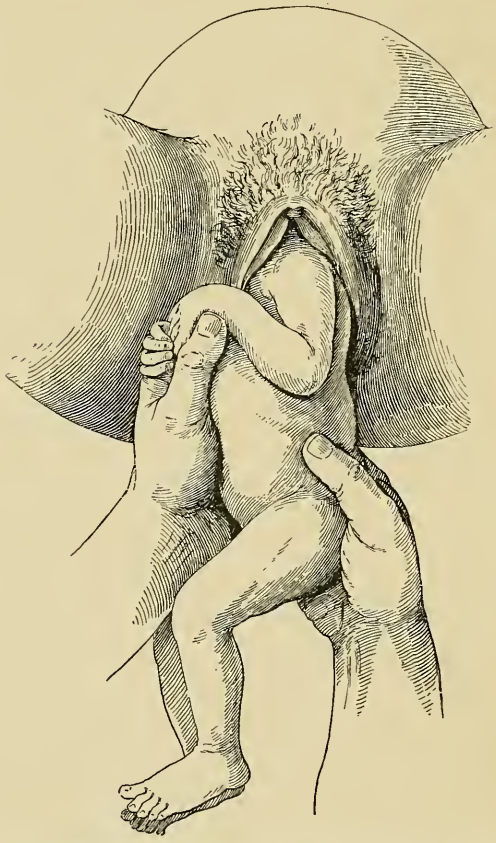


Fig. 187.—Breech Presentation, showing how to hold the Body of the Child. (Ribemont-Dessaignes and Lepage.)

Note.—The body should be wrapped up to protect it from cold air.

leg and then the other with the fingers passed into the vagina. The exposed parts must be wrapped up in a warm towel and carefully protected during the remainder of the labour, in order to avoid the risk that cutaneous stimulation by cold air may prematurely excite the respiratory centre. The umbilical cord should be sought for and a loop pulled

down so that its pulsation may be watched during the remaining stages. Traction on the legs is not required at this period, and the temptation to pull must be steadily resisted, for it is obvious that traction will tend to produce extension of the spine, and this again will induce extension of the head, because the vertebral column articulates with the head nearer the occiput than the sinciput. But the descent of the trunk may be aided by pressure with the hand

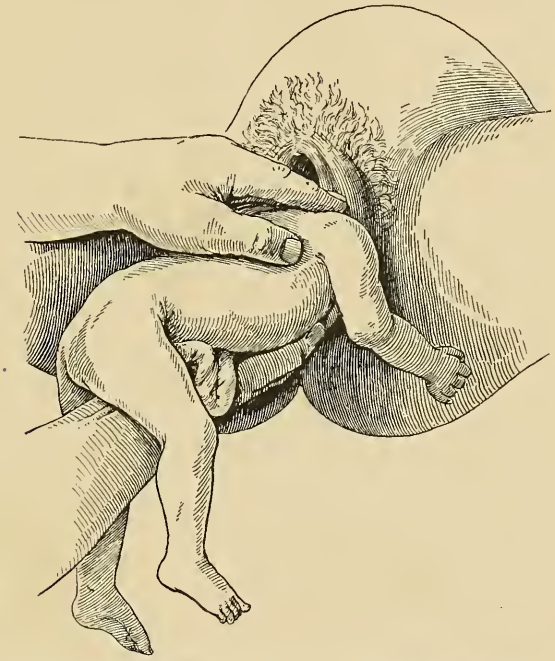


Fig. 188.—The Mauriceau-Veit Grip in delivering the After-coming of the Head. First Stage. (Ribemont-Dessaignes and Lepage.)

on the fundus during the pains; fundal pressure is also useful in maintaining the flexed attitude of the arms and head. As the trunk descends it will be observed to rotate as the shoulders pass into the antero-posterior diameter of the outlet, the direction of rotation being from right to left in the first position. If the normal attitude of the arms has been preserved, the elbows will then appear closely pressed against the chest. In holding the child at this stage, the hand should grasp the pelvis, not the waist (Fig. 187), lest

injury should be done to the abdominal viscera. When the child is small the head may be spontaneously disengaged by a voluntary effort of the mother; more often, however, assistance is required. The simplest method is to grasp the legs and carry the trunk of the child forwards parallel with the mother's abdominal wall, at the same time making pressure on the head in the axis of the pelvic brim (downwards and backwards) with the hand on the fundus. Frequently, however, this simple manœuvre does not suffice, and as the fœtal circulation is at this stage necessarily interfered with by compression of the cord or the placenta, prompt measures should be taken to deliver the head. The best method to adopt is that of Mauriceau or Veit—the credit of it is claimed for both (Figs. 188 and 189). The trunk of the child is taken upon the right forearm, with the legs astride, the index finger having been passed up to the face and inserted into the mouth in order to make traction upon the lower jaw. The left hand is placed upon the shoulders, the neck lying between the index and middle fingers. Traction is then made with both hands in the direction of the axis of that part of the pelvic cavity in which the head is lying. Flexion is maintained or extension corrected by the finger in the mouth, and descent may be aided by an assistant making pressure on the fundus. When the head reaches the outlet, the direction of traction must of course be changed (Fig. 189), and is now applied chiefly to the shoulders, the lower hand merely maintaining the flexion of head.

The grip of the head thus obtained is very effective; it is in reality a combination of two grips which were formerly practised separately, the anterior grip or jaw-traction being named after Smellie (Smellie grip), and the posterior grip after the great midwifery school of Prague (Prague grip). Time is, however, saved by employing them in combination, and success at this stage depends mainly upon the prompt application of effective methods. In the figures, the manœuvre is shown with the patient in the dorsal position; it can be equally well performed with the patient lying upon the left side, when the hands may be reversed.

If the head cannot be delivered in this way, the forceps should at once be applied. The child cannot survive

compression of the cord for more than five to ten minutes, therefore forceps should be always got ready for immediate use before commencing the delivery of the after-coming head.

Difficulties may arise during a breech labour at three different stages : (1) in the delivery of the buttocks, (2) in the delivery of the arms, (3) in the delivery of the head.

(1) The birth of the *buttocks* may be delayed (*a*) by

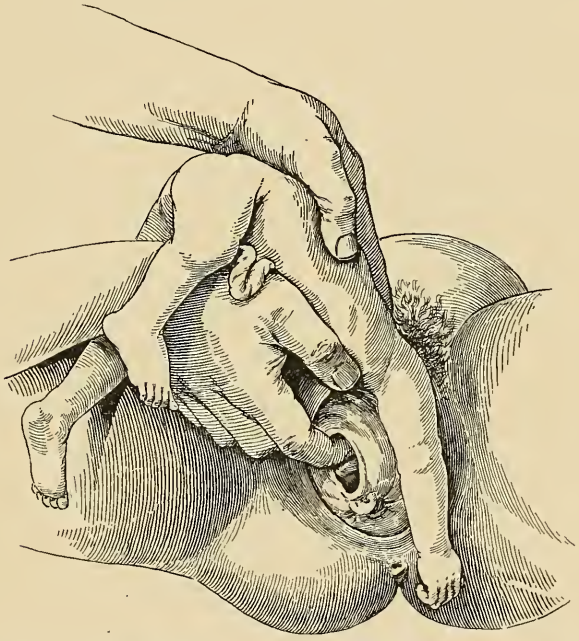


Fig. 189.—The Mauriceau-Veit Grip. Second Stage. (Ribemont-Dessaignes and Lepage.)

uterine inertia, (*b*) by the large size of the fœtus or the insufficient size of the pelvis, (*c*) by extension of the legs.

In the case of a primipara a further important cause of delay is always present in the narrow and relatively rigid vaginal canal. The breech forms an imperfect dilator, and the risk of extension of the arms is increased by the unyielding vaginal walls. Dilatation of the vagina may therefore be assisted by the use of de Ribes's bag during the second stage. It may be passed into the vagina as far up as possible, then inflated, and either left to be expelled by the natural

forces, or by making traction on the bag it may be gradually drawn through the vulva so as to dilate it in advance of the breech. This method also greatly facilitates subsequent manipulations, which may be required to bring down the arms or the head.

The safest and surest mode of dealing with difficulty in delivering the buttocks, no matter how it may be caused, is to bring down a leg; it is the best method whether the buttocks lie at the pelvic brim or in the cavity. An

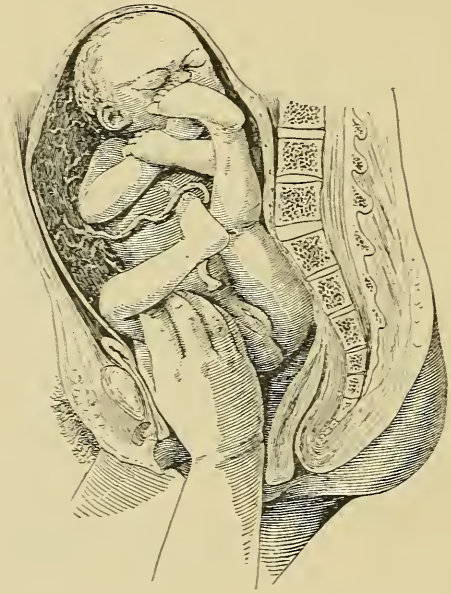


Fig. 190.—Breech Presentation. Bringing down a Leg.
(Ribemont-Dessaignes and Lepage.)

anæsthetic is required, and the entire hand is then passed into the vagina, strict antiseptic precautions being observed and rubber gloves worn. The anterior limb should be brought down in preference to the posterior. The fingers follow the anterior thigh up to the back and inner side of the knee, and pressure is then made upon the limb at this point so as to abduct it; this will flex the leg and bring the foot down within reach, so that it can be seized and drawn down into the vagina (Fig. 190). The same precautions must be observed in this manœuvre as in the operation of internal

version (see p. 681). A loop of the cord may come down with the leg ; it must be carefully replaced, well above the level of the buttocks. The expulsion of the child should now be left to the natural efforts, unless, from interference with the fœtal circulation, rapid delivery is indicated. In cases where this manœuvre is practised for uterine inertia, good pains will usually follow from the stimulation set up by the manipulations.

It occasionally happens that rapid extraction of a breech presentation becomes necessary from fœtal distress or from maternal complications. Both feet should then be brought down, and delivery effected by combined traction and suprapubic pressure. This cannot be attempted until the cervix is fully dilated.

When the breech is arrested in the *pelvic cavity*, difficulty

Fig. 191.—Breech Hook.

may be experienced in passing the hand beside the breech into the uterus, where the legs, if extended, will be found. Under deep anæsthesia it is, however, usually practicable to push the buttocks upwards to the level of the brim, when the hand can be slipped past them more readily. As an alternative the method of applying traction directly to the buttocks may be carried out either by the fingers or by the breech hook. The most effectual method of traction is by means of the Breech Hook (Fig. 191). This is a blunt-pointed metal hook, the width of which should be at least $2\frac{1}{4}$ inches. It is applied by passing it over the lateral aspect of the anterior buttock until the point lies above the level of the fold of the groin ; the instrument is then rotated through a right angle so as to bring the hook across the child's abdomen ; a finger is then passed between the thighs, and

the point of the hook is carefully guided into position on the inner aspect of the anterior thigh. Traction can then be applied in the fold of the groin, and if care and gentleness are exercised there is little fear of injury occurring. Fracture of the femur or pelvis, or dislocation of the hip may, however, occur if great force is applied ; therefore every effort should always be made to effect delivery by bringing down a leg, unless the child is dead, when there is no objection whatever to the use of the breech hook. When the arrest of the breech in the pelvic cavity is due solely to inefficiency of the uterine pains, traction with the fingers may succeed in delivering it. The index finger is passed over the dorsal aspect and then hooked into the groin ; whichever groin can be most easily reached can be made use of. Only one finger should be used and care taken to avoid direct pressure on the femur. The introduction of the finger will often be found to stimulate greatly the uterine contractions. Whatever method is employed traction is to be made only during the pains, and should be aided by pressure from above.

Traction may also be applied to the breech with the obstetric forceps, and this method is recommended by some authorities. This instrument is, however, ill-adapted for application to the breech, and if the points of the instrument are allowed to pass above the iliac crests, injury may be done to the abdominal viscera. The use of forceps is not to be recommended as a routine procedure, but may be tried after an attempt to bring down a leg has proved unsuccessful, as an alternative to the use of the blunt hook.

(2) Difficulty in the delivery of the *arms* results from their becoming displaced ; this is usually due to traction having been applied in delivering the buttocks, but it may also be due to disproportion between the size of the fœtus and the pelvis. The displacement is usually lateral (extension) as shown in Fig. 192. The shoulders will then probably lie in the oblique diameter of the brim ; therefore one arm will be anterior, the other posterior. On account of the curvature of the sacrum, it will be easier to reach the arms from behind than in front. The trunk should be first rotated into the transverse diameter, where there is more room for the necessary manipulations. The whole hand must then be passed along the trunk of the child into the

vagina, and the thumb and first two fingers carried along the humerus until the elbow is reached; the forearm can then be flexed over the face and chest, and the limb thus delivered. An anæsthetic is usually required for this manœuvre. There is no risk of injuring the limb if traction is applied only to the elbow or the forearm. Occasionally one arm becomes displaced laterally (extended), the other lies behind the

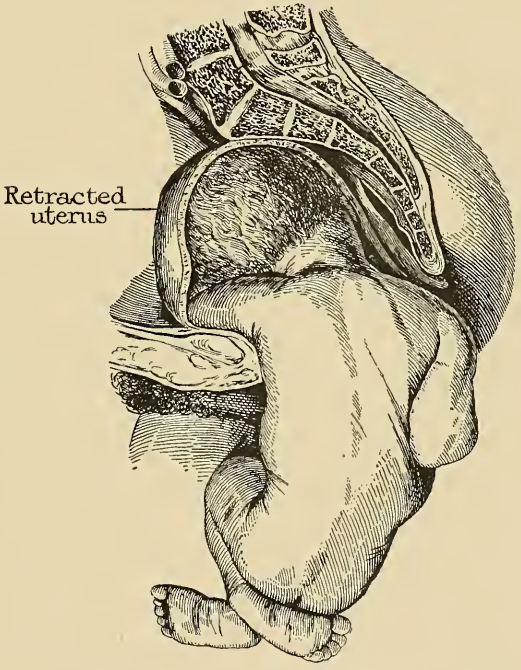


Fig. 192.—Lateral Displacement of the Anterior Arm; the Posterior Arm has been already brought down.

occiput. The extended arm should first be delivered; next the pelvis should be seized and the trunk rotated towards the same side as the limb which lies behind the occiput; this will bring the posterior arm into a lateral position, where it can be reached and delivered in the usual manner.

(3) Difficulty in delivering the *head* results either from its large size, from extension, from backward rotation, or from contraction of the pelvis. The mechanical disadvantage of extension of the after-coming head is indicated in

Fig. 193. When flexed, the head forms a wedge the apex of which is directed downwards ; when extended, the base of the wedge is directed downwards, and descent is therefore much more difficult. In addition, the occipito-mental diameter ($4\frac{1}{2}$ inches) engages instead of the sub-occipito-frontal (4 inches). If the extended head is delayed at the brim, it should be first rotated into the transverse diameter, and then flexed by traction on the lower jaw with the finger passed

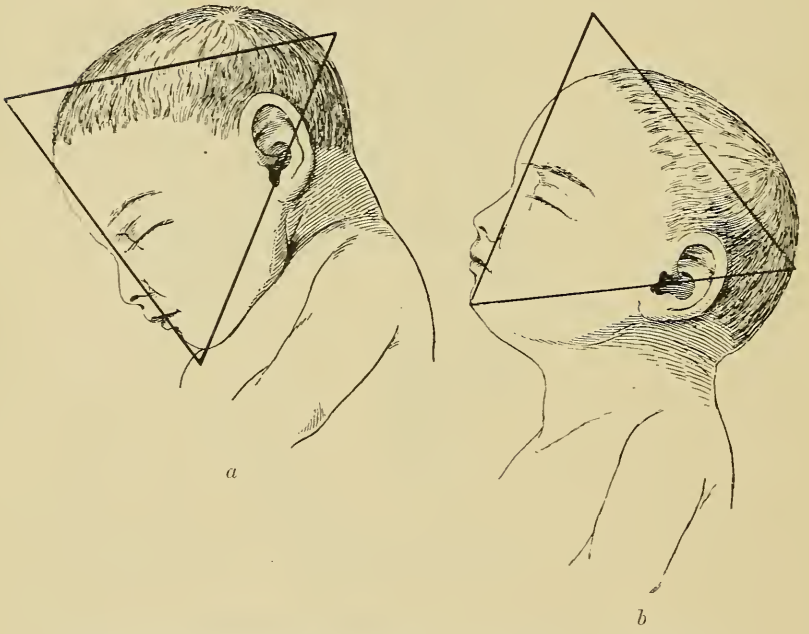


Fig. 193.—The After-coming Head. *a*. Flexed. *b*. Extended.

into the mouth. It may then be rotated and extracted by the Mauriceau-Veit grip, or, if this fails, by forceps. When the head is already in the cavity forceps may be at once applied. Whenever the child is dead perforation should be performed without hesitation to secure easy delivery. If backward rotation has occurred, an attempt should be made to rotate the head and trunk so as to bring the occiput forwards ; should this fail, perforation will be required unless the head is very small.

Transverse or Shoulder Presentations

These presentations include all cases in which the long axis of the fœtus lies more or less directly across the long axis of the uterus—*i.e.* all varieties of the transverse or oblique *lie*. Some part of the trunk of the fœtus presents—almost invariably by its lateral aspect. The shoulder (acromion process) in most instances forms the denominator of the presentation ; but sometimes the arm becomes prolapsed and descends first into the vagina, while at other times the lateral aspect of the abdomen, or even the back, forms the actual presenting part.

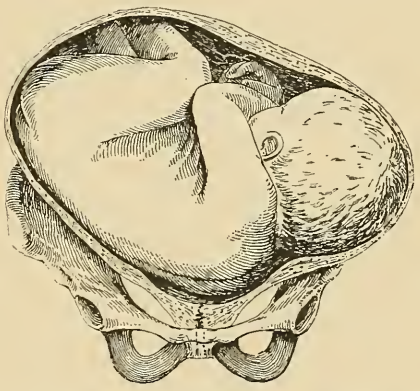


Fig. 194.—Shoulder Presentation: Dorso-anterior Position. (Ribemont-Dessaignes and Lepage.)

The general attitude of flexion is preserved.

It is usual to describe only two positions of the shoulder presentation, *dorso-anterior* and *dorso-posterior;* the former is much commoner than the latter, because the fœtus accommodates itself better in that position to the forward curvature of the lower dorsal and lumbar vertebræ. In the former the normal fœtal attitude of flexion is fairly well preserved (Fig. 194) ; in the latter the spine becomes extended and displacement of the limbs is frequently met with (Fig. 195) ; premature rupture of the membranes and prolapse of the cord are common in both positions. The head usually occupies the iliac fossa, the breech lying upon the opposite side at a somewhat higher level, so that the long axis of the fœtus is, strictly speaking, not transverse but oblique. More rarely the breech occupies the iliac fossa, while the head lies at the higher level.

Occurrence.—Shoulder presentations occur in about 1 in 200 (0·5 per cent.) labours. When premature labours are excluded the rate of frequency is much reduced. They

are five or six times more frequent in multiparæ than in primigravidæ.

Causes.—All conditions which prevent the ready descent of the fœtal head into the pelvic brim may occasion a shoulder presentation—*e.g.* pelvic contraction, hydramnios, placenta prævia, twins, extreme uterine obliquity, laxity of the uterine and abdominal muscles, premature or dead fœtus, &c. It will be recollected that the same conditions may cause other forms of abnormal presentation. The relative frequency of this presentation in multiparæ is probably to be explained by permanent weakening of the abdominal muscles, permitting forward or extreme lateral displacement of the uterus to occur.

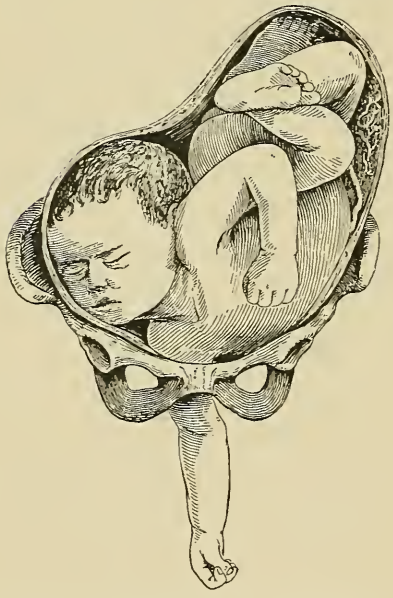


Fig. 195.—Shoulder Presentation: Dorso-posterior Position. (Ribemont-Dessaignes and Lepage.)

The spine is extended and the limbs are displaced.

Diagnosis.—This presentation can easily be recognised by abdominal palpation, *before labour has commenced*, or *early in the first stage* when the membranes are intact. The uterus is not pyramidal in shape, but irregular, the long axis lying more or less completely across the abdomen; as the presenting part cannot descend into the brim the level of the fundus is unaltered. Systematic palpation will show that the head occupies one or other iliac fossa, and usually that the back is anterior; the breech will then be found on the opposite side and at a higher level than the head; occasionally however, the breech will be found in the iliac fossa. Auscultation of the fœtal heart does not assist the diagnosis of this presentation.

In examining women who are several weeks short of

full time, transverse presentations are comparatively frequently met with ; probably a certain proportion of them become corrected spontaneously before labour. The lie in such cases is often quite irregular, the whole body of the fœtus lying well above the pelvic brim.

Nothing can be made out on vaginal examination before labour, except that the presenting part lies high up and is soft to the touch. During the first stage a large and elongated bag of waters will form, in which a small part—the arm—may be felt ; if the membranes have ruptured, the arm may become prolapsed early in labour.

Late in labour, when the liquor amnii has escaped and the uterus has become moulded around the body of the fœtus, detailed abdominal palpation is very difficult, and the position of the different parts of the fœtus cannot in this way be made out. Diagnosis must then be made by *vaginal examination*. A prolapsed arm will, of course, settle the presentation at once, and the position of the head and back can be deduced from the relation of the hand when supinated : the thumb pointing to the head, the palm corresponding to the ventral aspect. When prolapse of the arm does not occur, diagnosis will be more difficult. In almost all cases, however, the ribs with their intercostal spaces, or the vertebral spines, can be recognised with the finger, which usually reaches the former along the posterior axillary border (Fig. 196) ; these parts can hardly be mistaken for anything else. The angle of the scapula, freely movable and projecting from the surface of the back, may also be recognised, and is useful as indicating the position of the back. The acromion process and the curved clavicle may also sometimes be identified. By passing the exploring finger towards the right or left side of the mother, the finger can be passed into the pit formed by the apex of the axilla ;

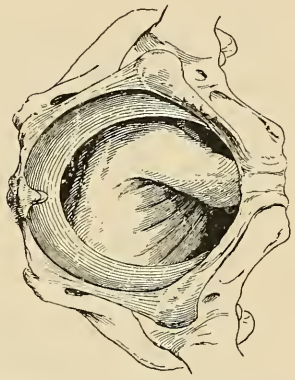


Fig. 196.—Shoulder Presentation : Dorso-posterior Position. (Ribemont-Dessaignes and Lepage.)

Patient in usual obstetric position.

the head, of course, lies upon the same side of the pelvis as the axillary pit.

Mechanism.—Natural delivery in a shoulder presentation is impossible when the fœtus is full sized ; under exceptional circumstances, however, it may take place in one of the following three ways :

A. *Spontaneous version* may occur—*i.e.* the presentation may spontaneously become transformed into a breech or a vertex. This occurrence has been observed early in labour, before the membranes have ruptured or the presenting part has become engaged. It was first described by an English obstetrician of the eighteenth century named Denman. The term 'spontaneous version' is usually applied only to the transformation of a shoulder into a breech presentation ; when transformed into a vertex the process is called *spontaneous rectification.* This is an unnecessary distinction, since version may be either cephalic or pelvic (see p. 671). No precise observations have been made upon the mechanism of spontaneous version ; its occurrence is no doubt very rare.

Fig. 197.—Attitude of the Fœtus in Spontaneous Evolution. From Nature. (Ribemont-Dessaignes and Lepage.)

B. *Spontaneous evolution* may occur when the fœtus is small or macerated, the pelvis large, and the uterine contractions powerful. This process, first described by a Dublin obstetrician, Douglas (beginning of nineteenth century), has been studied by Ribemont-Dessaignes and others who were able to obtain photographs of the different stages of delivery. The attitude assumed by the fœtus is shown in Fig. 197 ; extreme flexion of the head and the cervical spine occurs, causing severe compression of the thoracic and abdominal viscera ; and even if the fœtus is alive at the onset of labour, death invariably occurs during delivery. Prolapse of the

posterior arm first takes place, and the head and trunk then become compressed by the uterine contractions into the smallest possible bulk. After the expulsion of the prolapsed arm and shoulder (Fig. 198) the anterior shoulder appears under the symphysis, and the back follows, being expelled in the oblique diameter of the outlet. As the disengagement of the trunk proceeds, a movement of rotation occurs, carrying it into the transverse diameter, the head being on one side, the breech on the other (Fig. 199). Forward rotation of the shoulders next takes place, bringing the neck under the symphysis pubis, and the legs become disengaged in the antero-posterior diameter (Fig. 200). Labour terminates like a breech case with the delivery of the after-coming head. The fœtus represented in these figures (photographed from nature) weighed five and a half pounds.

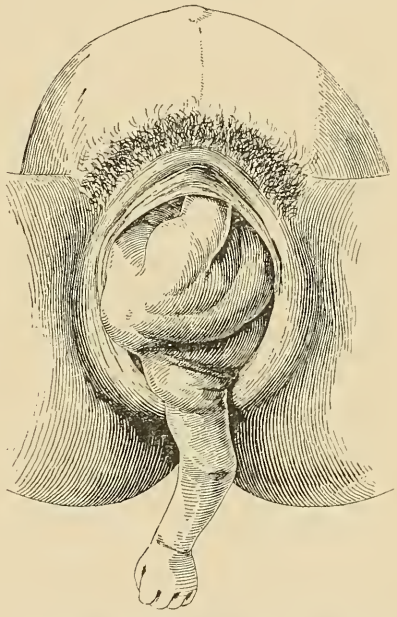


Fig. 198.—Spontaneous Evolution, Photographed from Nature. First Stage of Delivery, showing Prolapse of Posterior Arm. (Ribemont-Dessaignes and Lepage.)

In Fig. 201 is shown the process of evolution arrested at an early stage by the death of the mother. The attitude of the fœtus is similar to that shown in Fig. 197, and the greater part of the trunk has been driven into the vagina. This constitutes what is clinically known as an 'impacted shoulder.' The special risks which attend all methods of delivery in impaction of the shoulder are indicated by the condition of the uterus. It will be seen that the lower uterine segment is thinned, the bladder greatly elevated, and the upper part of the uterus much retracted.

C. *Spontaneous expulsion* is also described as a possible termination in the case of a macerated fœtus. From the accounts of observers who have watched the process, it is clear that it does not differ in any important respect from spontaneous evolution, and scarcely deserves to be recognised as distinct from the latter. The trunk of the macerated fœtus is very compressible, and may therefore be more completely bent upon itself, allowing the head and breech to be disengaged together (Fig. 202).

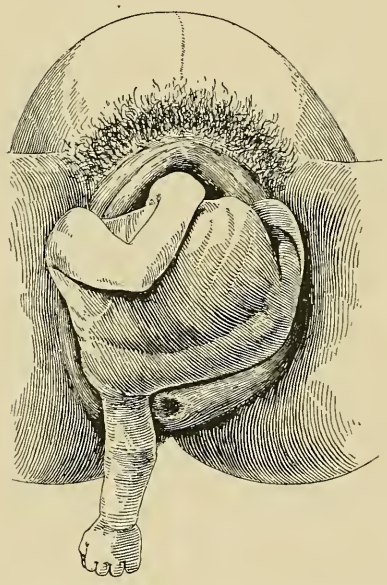


Fig. 199.—Spontaneous Evolution. Second Stage, showing Delivery of Back in the Transverse Diameter. (Ribemont-Dessaignes and Lepage.)

It must be clearly understood that these natural terminations of shoulder presentations are exceptional occurrences, and cannot under any circumstances be awaited. This presentation must invariably be dealt with by immediate interference in the manner indicated below. If allowed to continue, the case will in all probability become one of *obstructed labour;* over-distension of the lower uterine segment will ensue (see p. 463), the child will die of compression, and the mother, unless rescued by operative measures, will die undelivered, either of exhaustion or of rupture of the uterus.

Management.—Since it is impossible, under ordinary conditions, for natural delivery to take place in shoulder presentations, the treatment consists in converting the presentation into a vertex or a breech by one of the methods of version, provided that labour has not advanced too far to permit of this being done. These methods will be described in connection with the obstetric operations. If abdominal examination is regularly practised during the latter weeks

of pregnancy, shoulder presentations may be discovered before the onset of labour, and at this time they can be corrected by external version with ease and with perfect safety both to the mother and the fœtus. If the pelvis is of normal size, cephalic version should be practised. The mal-presentation is, however, apt to recur, as will be readily understood if its causes are borne in mind. After correction of a shoulder presentation in pregnancy the patient should accordingly be examined every few days until labour begins.

When the diagnosis is made early in labour and the membranes are intact, the mal-presentation can also, as a rule, be corrected by external version. At this stage it is better to perform external podalic version, and then rupture the membranes and bring down a foot into the vagina, so as permanently to correct the mal-presentation. This can be carried out without difficulty if the cervix is large enough to admit two fingers under anæsthesia.

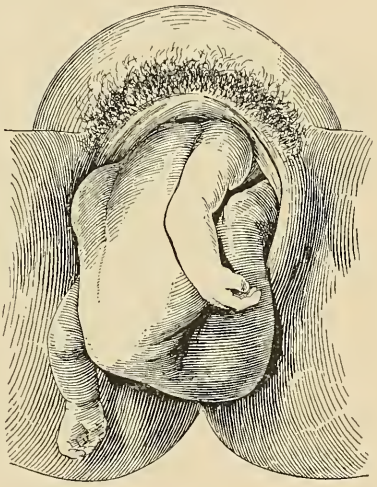


Fig. 200.—Spontaneous Evolution. Third Stage, showing Forward Rotation of Shoulders and Delivery of Legs. (Ribemont-Dessaignes and Lepage.)

If the membranes have already ruptured and an arm is prolapsed, external version is impossible. In such cases a loop of the cord also may become prolapsed, a complication which adds greatly to the fœtal risks. These complications may be dealt with as follows: (1) If the cervix is one-fourth dilated (two fingers), the patient should be anæsthetised, the prolapsed parts carefully returned into the uterus, and a de Ribes' bag then introduced into the cervix. This will prevent recurrence of the prolapse, and at the same time dilate the cervix and prevent further escape of liquor amnii. (2) If the cervix is one-half dilated the hand may be passed into the uterus, and the child turned by

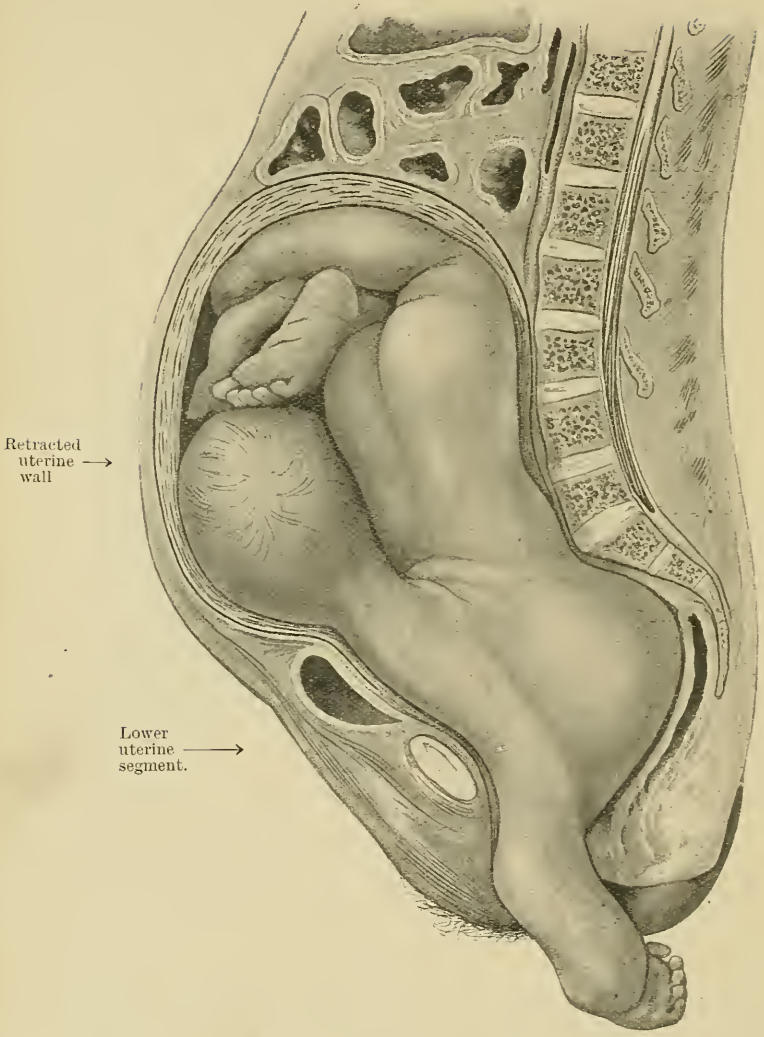


FIG. 201.—Impacted Shoulder Presentation illustrating a stage of Spontaneous Evolution. Section from a woman who died in labour. The lower uterine segment is greatly thinned, and the bladder lies completely above the pubes. (Barbour.)

bringing down a leg (internal version), the cord at the same time being returned into the uterus, where it will be safe from compression. Delivery may then be left to nature.

(3). Sometimes shoulder presentations are not seen until labour is advanced, the liquor amnii has all drained away, and the uterus is retracted over the body of the fœtus (Fig. 201). As will be seen in a later section, this condition, if allowed to continue, is attended by a very grave maternal risk, viz., rupture of the uterus. Version under these conditions is, generally speaking, impracticable, and any attempt to effect it, unless conducted with great care and skill, is liable to precipitate a rupture. Version therefore is not to be recommended, (*a*) unless sufficient liquor amnii remains in the uterus to allow some degree of mobility to the fœtal parts; (*b*) unless the uterus becomes well relaxed between the pains, showing that there is no tonic contraction (see p. 449); (*c*) unless there are no signs of over-distension of the lower uterine segment, such as undue prominence, and unduly high level of the retraction ring (see p. 463). When the conditions are such as to negative version the fœtus is practically always dead, and the method of delivery may accordingly be selected with reference solely to the interests of the mother. The usual method employed is decapitation, followed by separate delivery of the trunk and the head. In all cases, when the conditions present are unfavourable for version, and the fœtus is dead, decapitation should be preferred.

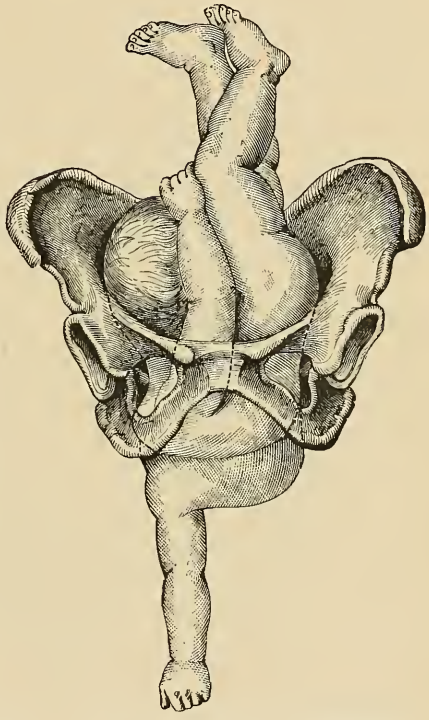


Fig. 202.—Transverse Presentation. Delivery by Spontaneous Expulsion. (Kleinwächter.)

Twin Labour

The diagnosis of twin pregnancy has been considered on p. 101.

Presentation.—The two fœtuses are almost invariably placed side by side in the uterus, the *lie* of each being longitudinal ; more rarely one is placed entirely above the other.

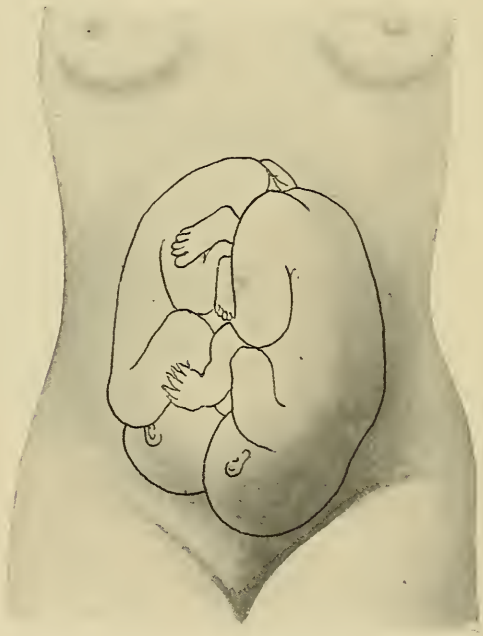


Fig. 203.—Twin Labour ; both Fœtuses presenting by the Vertex.

The commonest presentations are the following, the proportions being those compiled by Leonhard :

First child vertex, Second child vertex		38·5%
First ,, vertex, Second ,, breech. . . .		21·1%
First ,, breech, Second ,, vertex. . . .		14·3%
First ,, breech, Second ,, breech. . . .		10·7%
First ,, vertex or breech, Second child shoulder .		12·5%
		97·1%

The remainder are made up of various combinations, the

rarest of all being that in which both presentations are transverse.

The *diagnosis* of twins is often easier at term or during labour than at earlier periods of pregnancy. If the fœtuses are placed as in Fig. 204 it will be comparatively easy to determine the presence of two heads, one at the brim and one at the fundus. If, however, the twins are placed one in front of the other the presence of the posterior (Fig. 203) may escape the most careful observation. When the cervix is dilated two bags of membranes may sometimes be felt.

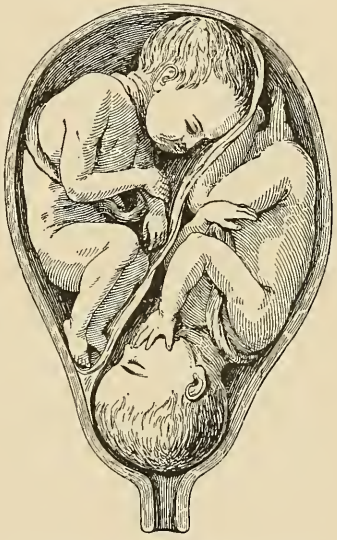


Fig. 204.—Twin Labour: First Fœtus presents by the Vertex, Second by the Breech (incomplete).

General Course of Labour.—With twins, labour frequently comes on prematurely, and shows an increased liability to the occurrence of certain complications, such as (*a*) hydramnios (usually affecting one sac only), (*b*) premature rupture of the membranes, (*c*) prolapse of a loop of the cord or a limb, (*d*) uterine inertia, (*e*) complex presentations. As a consequence, twin labour is usually somewhat prolonged; this is due partly to weakness of the over-distended uterine wall, which results in primary inertia (see p. 443), and partly to the fact that the stage of expulsion is duplicated. These disadvantages are to some extent counterbalanced by the small size of twin fœtuses. In other respects the course of labour depends entirely upon the relation of the fœtuses to one another. When the pelvis is full-sized or unusually large, the first fœtus, being small, does not fill it, and the presenting part of the second may enter the brim simultaneously with the first; the passage of both will thus become obstructed; this is known as *twin locking*. It must be recollected that this complication is extremely uncommon,

and, according to Von Braun, occurred only once in 90,000 deliveries in Vienna ; as twin labour occurs in something like 1 in 80 to 90 cases, it follows that twin locking occurred, in Von Braun's series, in only 0·1 *per cent. of twin labours.* The following are the principal varieties : (1) two vertex presentations ; one head lying in advance of the other, the vertex of the second enters the brim together with the neck of the first, and neither can make progress ; (2) first breech, second vertex presentation ; the vertex of the second enters the brim in advance of the after-coming head of the first, and the two heads become locked either *chin to chin, side by side, occiput to chin,* or *occiput to occiput ;* (3) the first presents by the vertex or breech, the second transversely. In varieties (1) and (2), natural delivery is possible if the pelvis is large, the uterine contractions are powerful, and the fœtuses are small ; when these conditions are not present, and invariably in the third variety, insuperable obstruction to natural delivery will result. Locking occurs quite as frequently with binovular as with uniovular twins.

Management.—Since the first child almost invariably presents by the head or breech, its delivery may be left to the natural efforts. In some cases of binovular twins with independent placentæ, the first after-birth may immediately follow the delivery of the first child. This is, however, quite uncommon ; as a rule both placentæ follow the birth of the second child. Usually the uterine contractions cease for fifteen to thirty minutes after the birth of the first child ; then they return, and the second, if presenting favourably, is quickly delivered, for the passages have been already fully dilated. Occasionally a delay of many hours or even several days may intervene between the natural expulsion of the first and the second child. A vaginal examination should be made immediately after the birth of the first child to recognise the presentation of the second ; if vertex or breech, nothing need be done ; if transverse, external or internal version should be performed ; the latter will be usually very easy on account of the small size of the fœtus and the relaxed condition of the passages. When the lie of the fœtus is longitudinal, the membranes may be ruptured artificially if the uterine contractions do not return effectively in half an hour ; but a short period of rest for the uterus is natural

and probably serviceable, therefore undue haste should be avoided. The delivery of the second child by version or forceps can safely be accelerated as soon as labour pains have been re-established, since the passages have been already fully dilated. The *third stage* should be conducted with the greatest care and patience ; the uterus quickly becomes exhausted, and, the area of the placental site being unusually large, the risks of post-partum hæmorrhage are increased. When dividing the cord of the first child between two ligatures in the usual manner, care should be taken to tie the distal ligature securely, for if an anastomosis should exist between the two placental circulations (umbilical), the second child may bleed through the cord of the first.

Twin locking is dealt with by sacrificing the first child, which is usually dead, in the interests of the second, if the fœtal entanglement cannot be cleared by manipulation under anæsthesia. In the first variety, the lower head may be sometimes extracted after pushing up the upper head out of the way ; if this fails, the first head must be perforated and crushed, for if not already dead the chances of the survival of the first child are necessarily endangered, while the second child has not yet suffered much from the effects of labour. In the second and third varieties, the first fœtus will almost inevitably perish ; it may be decapitated, or the head perforated, and after delivering it an attempt should be made to save the second by the application of forceps or by version.

Prolapse of the Umbilical Cord and the Limbs

A loop of the umbilical cord sometimes descends below the presenting part ; when this occurs before the membranes have ruptured, the condition is called *presentation* of the cord. After rupture the loop will descend into the vagina or may even protrude at the vulva ; this is *prolapse* of the cord.

Causes.—Descent of the cord is more likely to occur when the presenting part imperfectly fills the pelvic brim than when the conditions are normal ; it is therefore chiefly met with in presentations of the breech or shoulder, when there is

pelvic contraction, hydramnios, or twins, or when the fœtus is unusually small, as in premature labour ; other conditions which favour its occurrence are placenta prævia, an abnormally long cord, and the lax condition of the uterus found in multiparæ.

Diagnosis.—The loop of cord is easily recognised whether the membranes are intact or ruptured. If the fœtus is dead and pulsation has ceased, *presentation* of the cord may be mistaken for a hand or foot, but with *prolapse* no mistake is possible.

Risks.—Prolapse of the cord does not increase the maternal risks of labour, except in so far as the manipulations required for its replacement involve slight additional risks of sepsis. The fœtus is in great danger of death by asphyxia from compression of the cord between the presenting part and the pelvic wall, or the lip of the imperfectly dilated cervix ; the fœtal mortality in this condition is about 25 per cent. The risks are greater when the presentation is a vertex than in abnormal presentations, for serious compression can hardly be avoided when the head is in the brim. Descent in front of the head (anterior) is more dangerous than descent behind it (posterior), for in the latter the cord may lie near one of the sacro-iliac synchondroses and thus entirely escape compression, while in the former the loop is certain to be compressed between the head and the anterior pelvic wall. If in a flat pelvis the loop comes down at the side so as to lie in the long transverse diameter, it is very favourably placed to avoid compression. The risk is less in a multipara than in a primigravida, for in the former labour can be terminated more rapidly.

Management.—When it is found that pulsation in the cord has entirely ceased the fœtal heart should be auscultated, and if no sounds are heard, the case may be left to terminate naturally, as the fœtus is dead. If compression of the cord has lasted but a short time, the heart may continue to beat. When the fœtus is still living interference in its interest is required.

Presentation of the cord is best treated by posture. The aim of postural management is to place the patient in an attitude in which the fundus of the uterus lies at a lower level than the cervix, so that the action of gravity will

promote the return of the presenting loop into the uterine cavity. The most effectual method is to place the patient in the genu-pectoral position (Fig. 205), in which the body is supported upon the knees and the upper part of the chest, the arms being folded beneath it. Another less effectual, but also less troublesome method, is the knee-elbow position, in which the body rests upon the knees and forearms (Fig. 206). The knee-chest is more effectual than the knee-elbow position, because in the former the fundus lies at a relatively

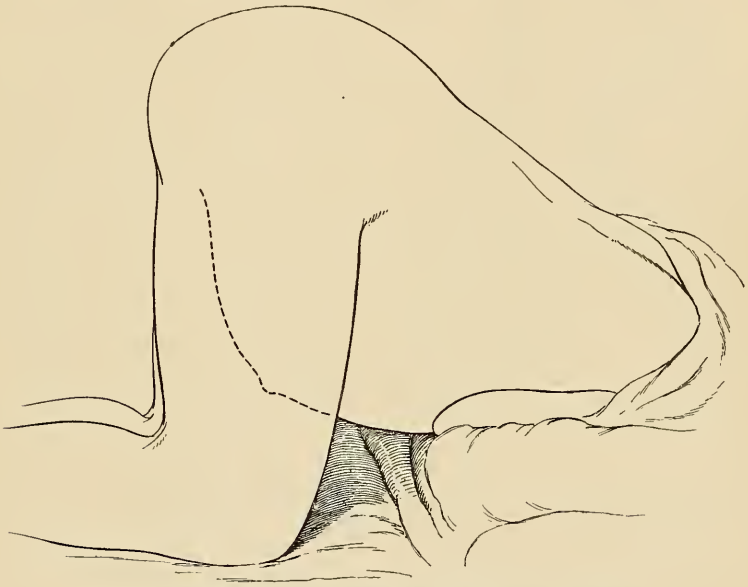


Fig. 205.—The Knee-Chest (Genu-Pectoral) Position.

lower level than in the latter. Both of these postures are very irksome, and cannot be maintained for more than ten to fifteen minutes at a time ; the patient should then be placed upon her side, and the postural treatment resumed after an interval. In hospital practice the Trendelenburg position has been employed, and with a suitable table it is possible to obtain a posture in which the patient is nearly upside down ; but it is obviously unsuitable for general use. These postures frequently fail to effect reduction. The greatest care should be taken to preserve the membranes, for while they remain intact there is little or no risk of

compression. The possibility of pelvic contraction must be remembered, but no other treatment is required at this stage, as the fœtus is not in immediate danger.

Prolapse of the cord with a *partially dilated cervix* should in the first instance be treated by *digital* reposition. An anæsthetic is administered, the gloved hand passed into the vagina, and the cord then pushed into the uterus well above the presenting part. In vertex presentation a tight abdominal binder may then be applied, to keep the presenting part well down in the pelvic brim, and so prevent recurrence

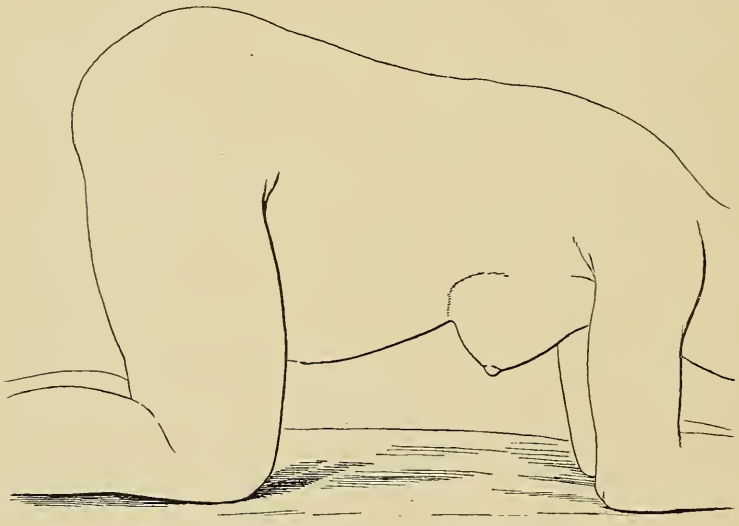


Fig. 206.—The Knee-Elbow Position.

of the prolapse. With the same object, in breech presentation a leg should be pulled down into the vagina. *Instrumental* methods of reposition are also sometimes adopted, but they are inferior to the digital method, for by the former a portion of the loop may easily be left in a dangerous position, unknown to the operator. A simple repositor can be constructed from a piece of narrow tape and a gum-elastic catheter (Fig. 207). A suitable length of tape is boiled, and the catheter is sterilised and prepared by making a counter-opening opposite the eye ; through this the ends of the tape are then threaded. The loop of tape is now made to encircle the prolapsed loop of cord and is then drawn sufficiently

tight to hold it without undue compression. The catheter, along with the snared loop of cord, is next pushed up into the uterus as high as possible, and left there to be expelled with the body of the fœtus.

If in a vertex presentation the cervix is not sufficiently dilated to allow reposition to be properly effected, or if the cord comes down again after having been replaced, a de Ribes' bag should be introduced after careful reposition of the prolapsed loop ; this will effectually prevent recurrence, in addition to dilating the cervix. In a breech presentation the risk of compression is decidedly less. If the cord can be properly replaced, it is sufficient to pull down a leg and leave delivery to nature ; if there is difficulty in replacing it, the dilating bag should be employed.

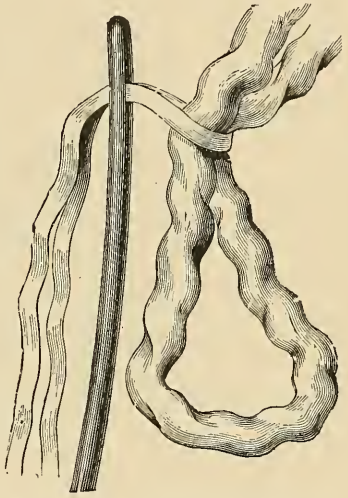


Fig. 207.—Instrumental Reposition of Prolapsed Cord. (Galabin.)

When the cervix is *fully dilated*, prolapse of the cord should in all cases be treated by immediate delivery by version or forceps. If the head has passed the brim, the cord cannot possibly be replaced nor can version be performed ; rapid extraction with forceps offers the best chance of saving the child.

Prolapse of Limbs.—Occasionally a vertex presentation is complicated by descent of the arm or the leg, so that the hand or foot enters the pelvic brim along with the head (Fig. 208). This occurs more frequently with premature labour or with twins, or when the pelvis is contracted, than under normal conditions. Such a presentation is usually called *complex*. Prolapse of the foot is much rarer than prolapse of the hand. When the head is of small size, prolapse of the hand does not prevent natural delivery ; if, however, the cervix is fully dilated, the hand should be replaced under anæsthesia, and the head then delivered with

forceps, care being taken to avoid compression of the arm by the blades. Earlier in labour, when the cervix is incompletely dilated, version should be performed.

In a transverse presentation both the arm and the leg sometimes become prolapsed, and along with them a loop of the cord may descend. This gives a complex presentation which offers considerable difficulties in diagnosis. The

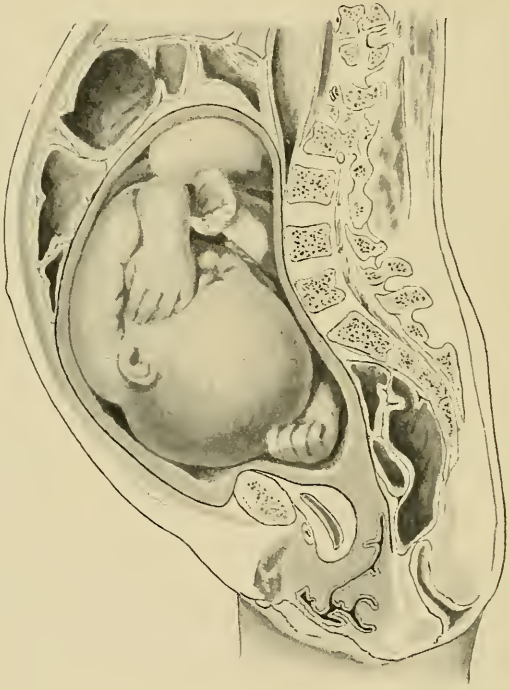


Fig. 208.—Presentation of the Head and Arm.
(Galabin and Blacker.)

treatment is version in all cases, when the labour is not too far advanced for this operation to be safely performed.

Pelvic Contraction

The female pelvis may be variously altered in size alone, or in size and shape, by errors of development, by local or general bone disease, or by the results of accident. The

frequency of pelvic contraction varies greatly in different localities, being much more frequent in large cities than in rural districts. Among over 50,000 labours in the University Klinik in Vienna between 1878 and 1895, pelvic contraction occurred in 2·5 per cent. of all cases. At Queen Charlotte's Hospital, London, it was found that in 10,000 labours 4 per cent. of cases of contracted pelvis occurred. A large number of different types exist, but most of them are of rare occurrence, and their effects upon the course of labour have not received detailed individual study. Two types are, however, of comparatively frequent occurrence, and must

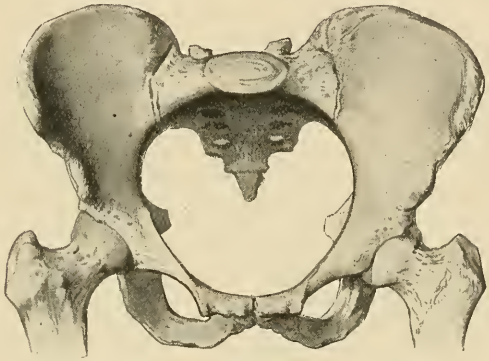


FIG. 209.—Generally Contracted Pelvis.

therefore be fully considered ; the others will be only briefly referred to.

1. **The Generally Contracted Pelvis** (Small round pelvis : Pelvis æquabiliter justo-minor).—This form of pelvis (Fig. 209) differs from the normal mainly in size, all the diameters being *proportionately* diminished, while the general shape is preserved. Minor differences, however, exist in the inclination of the plane of the brim and in the curvature of the sacrum. The promontory lies at a level higher than normal ; and the angle made by the plane of the brim with the horizon is therefore somewhat increased (compare Figs. 106 and 209). The concavity of the sacrum from side to side is deepened, while that from above downwards is diminished ; these changes slightly exaggerate the diminution of the antero-posterior diameter of the cavity. All the dimensions of the outlet are proportionately reduced. The

shape of the false pelvis is unaffected, but its diameters are also diminished. Sometimes pelves of this variety approximating to the male type are met with.

Nothing is definitely known of the causes of this form of pelvic contraction; it is said to be the variety most commonly met with in America (Edgar), but in European countries the rachitic forms predominate. It may be met with in women whose development is otherwise normal; it is also frequently found in dwarfs who are not the subjects of rickets.

2. The Flat Pelvis.—The characteristic features of this form of contracted pelvis are: (1) reduction in length of the conjugate diameter of the brim, and (2) an abnormal curvature of the iliac crests. Two varieties are distinguished—viz., one in which no other changes than those just mentioned are found, and one in which changes also occur in the pelvic cavity and outlet. By some writers these varieties are respectively termed *non-rachitic* and *rachitic*, the latter being attributed to rickets in all cases. By others, both varieties are attributed to rickets, and they are then respectively termed the *elliptical* or *simple flat pelvis*, and the *reniform flat pelvis*. The latter is clearly rickety, but the evidence upon which the former is attributed to rickets is inconclusive, and we shall therefore adopt the names *non-rachitic* and *rachitic* flat pelvis for these two varieties.

In the *non-rachitic flat pelvis* the deformity is never extreme; the patient is usually well developed in other respects, and shows no rickety changes in any other part of the skeleton. The anterior portions of the iliac crests are not incurved to the same extent as in the normal pelvis; consequently the distance between the anterior superior iliac spines (*interspinous diameter*) does not maintain its usual proportion to the distance between the summits of the iliac crests (*intercristal diameter*). This alteration has no influence upon labour, but is useful clinically, in furnishing an indication of the condition of the pelvic brim. The conjugate diameter of the brim may be reduced to 3 inches (7·5 cm.), but in this form of flat pelvis it is very rare to find a greater reduction than this. This change, to which the characteristic *flattening* is due, appears to be caused by slight forward displacement of the upper part of the sacrum.

The transverse diameter of the brim is increased, either absolutely (over $5\frac{1}{4}$ inches), or at any rate relatively to the length of the conjugate. The oblique diameters of the brim, as well as all those of the cavity and outlet, are unaltered.

In the *rachitic flat pelvis* the deformity may be, and usually is, much more pronounced than this. Such evidences of rickets will be found as curvature of the shafts of the long bones and enlargement of their epiphyses, beading and bending of the ribs, and perhaps diminutive stature. In marked cases the pelvis shows a series of characteristic changes. The outward displacement of the anterior

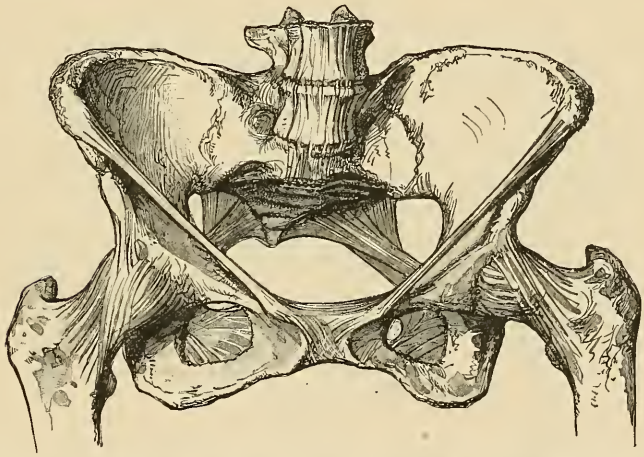


Fig. 210.—Rachitic Flat Pelvis, minor degree: showing Reduction of the Conjugate and Flattening of the Sacrum.

portion of the iliac crests is well marked, the iliac fossæ being directed nearly forwards, instead of forwards and inwards (compare Figs. 104 and 210). The sacrum, softened by disease, has been both bent and displaced forwards by the pressure of the body-weight; the promontory has therefore been carried nearer to the symphysis, and the concave anterior surface has become flat, or it may be even slightly convex (Figs. 210 and 212). In addition, rotation of the whole bone has occurred round a horizontal axis passing through the centre of the sacro-iliac synchondroses; this brings the promontory still nearer the symphysis, and carries the coccyx further away from it. The *outlet* of a rachitic flat pelvis. on

the other hand, is larger than normal (Fig. 212). Its antero-posterior diameter is increased by the rotation of the sacrum just described. Under the pressure of the body-weight transmitted by the innominate bones through the hip-joints to the legs, the lateral pelvic walls bulge outwards, increasing the transverse diameter of the brim; also the ischial tuberosities are carried further apart, thus increasing the width of the pubic arch and the length of the transverse diameter of the outlet. On looking into such a pelvis

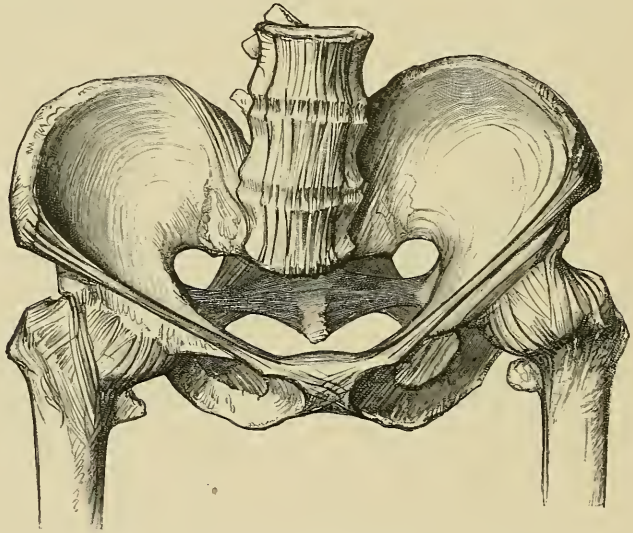


Fig. 211.—Rachitic Flat Pelvis, extreme degree: altered Curvature of the Iliac Crests.

The relative increase in the transverse diameter is well shown.

from below, the large dimensions of the outlet contrast with the contracted conjugate of the brim and the greatly exaggerated prominence of the sacral promontory (compare Figs. 212 and 216).

Sometimes in a rachitic flat pelvis the bodies of the pubic bones are distinctly incurved (beaked), encroaching still further upon the conjugate of the brim; when the latter deformity is well marked the pelvis is sometimes called, from the shape of the brim, the *figure-of-eight rachitic flat pelvis.*

The changes in a marked case of rachitic flat pelvis may be summarised as follows:

False Pelvis.—Relative increase in interspinous diameter.

Brim.—Conjugate diminished, transverse increased, shape reniform or figure-of-eight.

Outlet.—Transverse and antero-posterior increased, pubic arch widened, or in some cases narrowed (beaked).

Cavity.—Anterior surface of sacrum flat or convex.

The generally contracted flat pelvis (flat justo-minor pelvis) is a form in which diminutive size is associated with rachitic flattening ; the shape is that of the rachitic flat pelvis, but all the diameters are diminished in length. This form of pelvis is usually associated with advanced rachitic changes

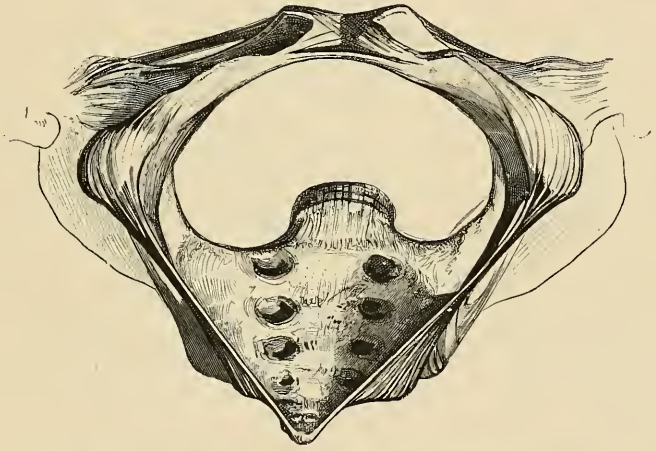


Fig. 212.—The Outlet of a Flat Pelvis seen from below.

in the skeleton generally, one of the most frequent of these being lateral curvature of the spine (scoliosis). When this change is present the resulting pelvic contraction is asymmetrical or oblique (Fig. 213). If the spine is fairly straight, the generally contracted flat pelvis remains symmetrical. The resulting deformity is, in either case, extreme, and gives rise to more serious difficulty in labour than either the flat pelvis or the small round pelvis.

In the Vienna statistics already quoted, the four varieties —non-rachitic flat pelvis, rachitic flat pelvis, generally contracted pelvis, and generally contracted flat pelvis, accounted for about 96 per cent. of all cases of pelvic contraction ; the remaining varieties are accordingly very uncommon. The

extreme cases of pelvic contraction met with in this country usually belong to the generally contracted flat variety.

Generally enlarged Pelvis (Pelvis æquabiliter justo-major). —This is not a *contracted* pelvis at all, but a pelvis of greater size than the normal, though proportionate in all its diameters. Its influence is not, as a rule, unfavourable, but it may be one of the factors in the causation of *precipitate labour* (see p. 442).

Diagnosis of Pelvic Contraction.—While the presence of a contracted pelvis may be surmised from the diminutive

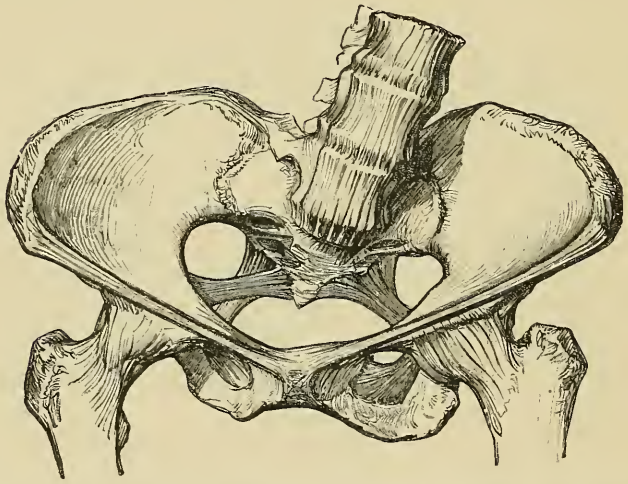
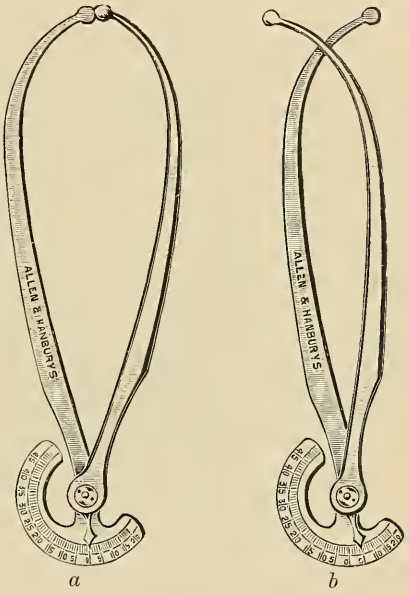


Fig. 213.—Generally contracted Rachitic Flat Pelvis, with Lateral Obliquity due to Scoliosis.

stature of the patient, from general evidences of rickets or other bone diseases, from lameness, or from the pendulous condition of the abdomen in pregnancy, it can only be certainly recognised by measurement. In the case of a multipara an obstetric history of previous difficult labour, in which the child was born dead or did not survive more than a day or two, should always arouse suspicion of the presence of pelvic deformity, although this will not in all such cases be discovered. The anatomical pelvic diameters described on p. 257 cannot be measured clinically, but certain other measurements of the living subject can be made, from which the size of the true pelvis may be inferred with approximate

accuracy. Such measurements must be made with great care, as it is very important for practical purposes to note the degree of contraction present in any given case.

The measurements of the pelvis which can be taken in the living subject are *external* and *internal*. They should, whenever possible, be taken with the pelvimeter; some, however, are best measured with the fingers. Methods of estimating the size of the pelvis are called *clinical pelvimetry*. The most useful form of pelvimeter for external measurements is that of Collin, shown in Fig. 214. It consists of a pair of callipers, furnished with an index which shows the distance between the points in all positions. The points can be separated from one another by opening the instrument like a pair of forceps, or in the reverse direction by crossing the blades. The latter position is used for measuring the transverse diameter of the outlet by pressing the crossed points deeply into the perineum, so as to bring them in contact with the inner borders of the ischial tuberosities. The instrument can also be used in this position for internal measurements. In using it for external measurements the instrument should be held by the points —one in each hand, and carefully adjusted to the required diameter, by firm pressure against the bone (Fig. 217). The index is then read off.



a *b*

Fig. 214.—Pelvimeter.

External Measurements.—(1) *Interspinous Diameter.* This is the distance between the outer borders of the anterior superior iliac spines; its average length is 10 inches (25 cm.).

(2) *Intercristal Diameter.* This is the distance between

the outer borders of the iliac crests where these are widest apart; the points of the pelvimeter are moved to and fro until the position of maximum separation has been found, which is usually about $2\frac{1}{2}$ inches behind the anterior superior spines. Its average length is 11 inches (27·5 cm.). From observations on the cadaver (Sandstein) it appears that this diameter approximately represents twice the length of the transverse diameter of the brim; and as the latter is very difficult to measure clinically, this relation becomes one

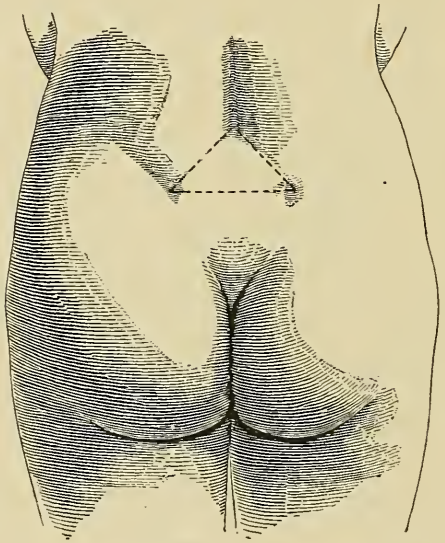


FIG. 215.—The Lumbo-sacral Spine with a Normal Pelvis. (Modified from Bumm.)

of practical importance. In a normally shaped pelvis the intercristal diameter is an inch longer than the interspinous diameter. This proportion is preserved in the generally contracted pelvis, although the length of both may be diminished, but in the flat pelvis there is less than an inch of difference between them, and in well-marked rachitic flattening the interspinous may even be equal in length to the intercristal diameter.

(3) *External Conjugate Diameter.* This is the distance between the tip of the spine of the last lumbar vertebra and the centre of the upper border of the symphysis pubis. This

diameter can be best measured in the erect position. The posterior bony point is difficult to find in fat subjects, but in thin women there is no difficulty. Whenever practicable the lumbar spines should be counted, and a palpable pit or depression will usually be found just below the spine of the fifth vertebra. One point of the pelvimeter is adjusted to this depression, and the other pressed carefully and firmly against the pubes in the position described. The average length of this diameter is $7\frac{3}{4}$ to 8 inches (20 cm.). When the

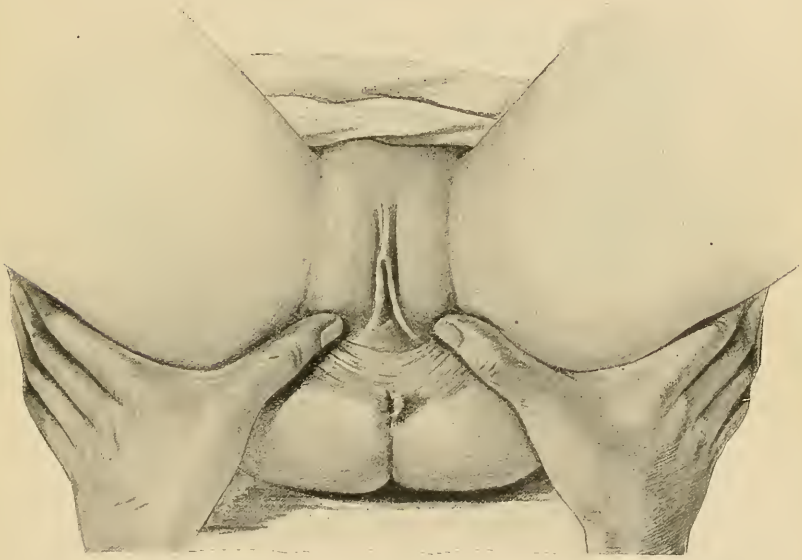


Fig. 216.—Estimating the Width of the Pelvic Arch by Palpation. (Williams.)

spine of the last lumbar vertebra cannot be clearly felt, it may be located as follows : the position of the two posterior superior iliac spines is first marked upon the skin ; these points are then united by a horizontal line ; a point $1\frac{1}{2}$ to $1\frac{3}{4}$ inches above the centre of this line will indicate the position of the fifth spine. Shallow depressions can often be recognised over these three bony points, and from them a rhomboidal figure may be constructed upon the lumbo-sacral region known as the *rhomboid* or *lozenge of Michaelis*, the lower sides being formed by the posterior borders of the

glutei maximi muscles, the upper sides by lines joining the fifth lumbar spine to the posterior superior iliac spine on each side. The relations of the three bony points to one another can, however, best be recognised by marking out a triangle upon the back as in Fig. 215 ; the base line represents the distance between the posterior superior iliac spines (*posterior interspinous diameter*). The length of the latter is variable, and consequently little importance can be

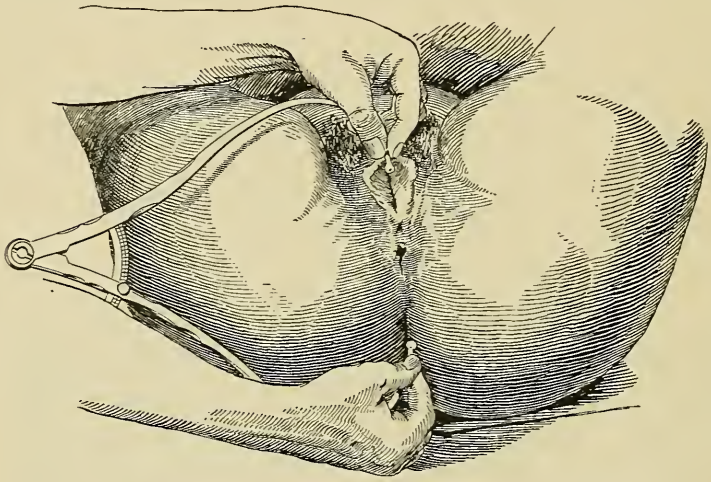


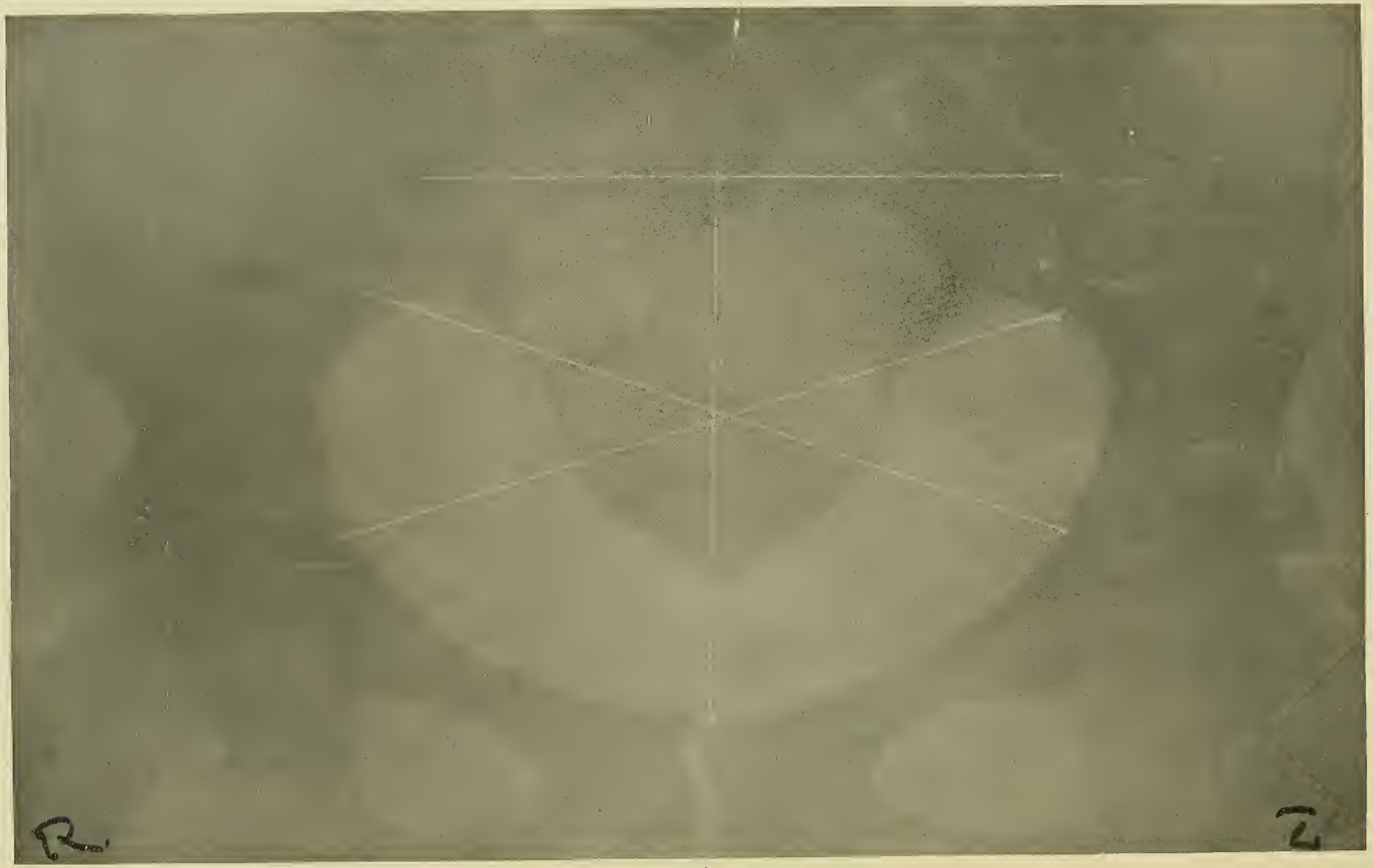
Fig. 217.—Measuring the Antero-posterior Diameter of the Outlet. (Bumm.)

attached to it ; the average is placed at 4 inches (10 cm.) in a normal pelvis.

In the case of a normal pelvis $3\frac{1}{2}$ to $3\frac{3}{4}$ inches (9·5 to 10 cm.) must be deducted from the external conjugate diameter to obtain the true conjugate ; if the pelvis is flattened, 4 to $4\frac{1}{4}$ inches (10 to 10·5 cm.) should be deducted in order to allow for the forward displacement of the upper part of the sacrum.

(4) The size of the pelvic outlet can also be measured clinically and is of considerable practical importance. The patient should lie on her back with the legs flexed and the buttocks brought to the edge of the couch. The width of the pelvic arch should first be estimated by palpation with the thumb in the manner shown in Fig. 216. After a little

PLATE IV.



Radiograph of a Normal Pelvis: the markings indicate the position of the diameters of the brim and the level of the sacral promontory.

experience a rough estimate of the arch as wide, medium, or narrow may be made, and this should be a part of the routine examination of all primiparæ. The actual measurements need only be made when a suspicion exists of contraction. The aid of an assistant is required for these measurements. The antero-posterior is taken from the lower border of the symphysis to the last sacral vertebra, a quarter of an inch being deducted for the thickness of the

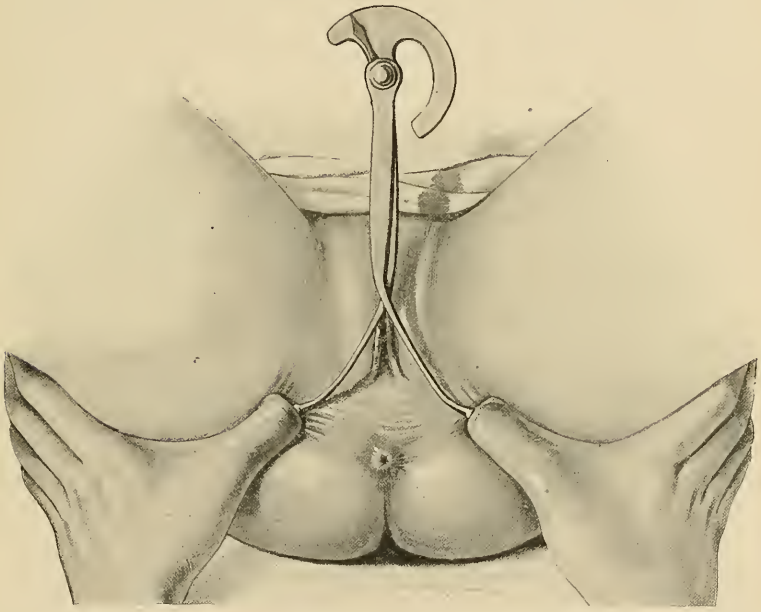


Fig. 218.—Measuring the Transverse Diameter of the Outlet. (Williams.)

sacrum (Fig. 217). In measuring the transverse diameter the inner borders of the ischial tuberosities are first defined with the thumbs (Fig. 218), and the distance measured between them.

Internal Measurements.—These can be made with the fingers alone, or with an internal pelvimeter. The most important diameter to be estimated by this method is the conjugate of the brim.

(1) *Diagonal Conjugate.* This is the distance from the

centre of the promontory of the sacrum to the centre of the lower border of the symphysis (Fig. 219). It can easily be measured with the fingers when the pelvic brim is considerably contracted, but it cannot be taken in labour when the presenting part is fixed in the brim. In common with other clinical measurements, it has the disadvantage that its relation to the true conjugate is variable, and difficult to estimate precisely. On an average it may be said to be from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch longer than the true conjugate—*i.e.* $4\frac{3}{4}$ to 5 inches. The factors which affect the diagonal

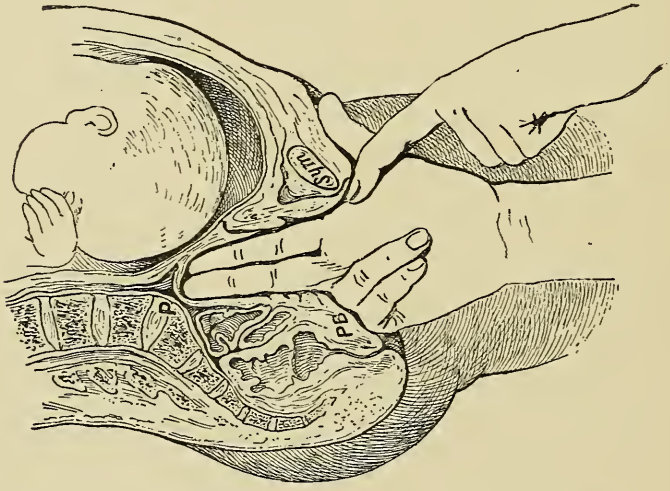


Fig. 219.—Measuring the Diagonal Conjugate. (Norris.)

conjugate to an extent which it is difficult to estimate are the *thickness* and *depth* of the symphysis, and the *angle* which it forms with the plane of the brim. This measurement can best be made with the patient lying on her back, the thighs flexed and supported by assistants, and the buttocks drawn over the edge of the bed ; it can also, however, be made in the usual obstetric posture, when no assistance will be required. The index and middle fingers are passed into the vagina and pressed upwards and backwards until the edge of the promontory can be felt with the tip of the middle finger. In a pelvis of normal size it is usually impossible thus to reach the promontory. Care must be

taken not to mistake the first sacral ridge for the promontory, for the diameter will then appear to be longer than it really is. When the finger is in contact with the promontory the bone at a higher level can be felt to recede so as to become more difficult to reach ; if a lower sacral ridge is touched the finger pushed further upwards is still in contact with the bone. The point where the lower border of the symphysis comes in contact with the hand is then marked off with the finger-nail, and after withdrawing the fingers the measured distance between this point and the tip of the middle finger represents the length of the diagonal conjugate. In many cases it is impossible satisfactorily to measure this diameter except under anæsthesia ; this is especially the case in minor degrees of contraction.

(2) Various methods have been introduced to measure the true conjugate and transverse directly by the use of an internal pelvimeter. The simplest form of internal pelvimeter is that of Skutsch, which may be used for both the conjugate and transverse diameters of the brim. This instrument consists of a pair of callipers with one rigid and one flexible arm, joined by a screw but not furnished with an index. In measuring the transverse the internal rigid limb is passed into the vagina and first guided up to the centre of the *right* lateral wall of the pelvic brim, while the point of the flexible limb is adjusted to the tip of the *left* great trochanter. The instrument is then withdrawn and the distance between the points measured off. The rigid limb is again passed and the point applied to the centre of the *left* lateral wall of the brim, the external limb being applied to the same point as before. The instrument is then withdrawn and the separation of the points again measured. The difference between the two measurements represents the length of the transverse diameter. In measuring the conjugate the tip of the rigid limb is placed against the centre of the promontory, and the flexible limb adjusted to the centre of the upper border of the symphysis ; the second measurement is taken with the rigid limb placed upon the centre of the posterior surface of the symphysis at its upper border. The difference between them represents the true conjugate. In practice this instrument is difficult to work with precision, and requires an anæsthetic. Experience

shows that a rough estimate of the size of the transverse diameter may be obtained by the simple expedient of endeavouring, with two fingers in the vagina, to trace the pelvic brim from the symphysis back to the promontory. If the transverse is of normal length this is very difficult, even under anæsthesia, but if contracted it will be quite practicable. This method can be controlled by halving the intercristal diameter.

(3) Another method of internal pelvimetry must be mentioned—viz., the method of Johnson. This consists in passing the whole hand into the vagina, and endeavouring to fit the closed fist into the conjugate of the brim. The author of this method elaborated it to such an extent as to define a series of positions of the thumb and fingers, each of which represented a definite length from 4 to 3 inches, and he claimed that he was thus able to measure the conjugate precisely. It is clear that, as hands are not of uniform size, there is abundance of room for error, which can only be eliminated by taking careful measurements of the hand in the various attitudes described by Johnson before attempting to apply it. A further objection is that the hand cannot be passed into the vagina except immediately after labour, and the method is therefore not available at the time when measurements are most required.

Clinical pelvimetry clearly yields results which are by no means precise. One measurement must be controlled as far as possible by others, but ultimately the carefully corrected diagonal conjugate is most to be relied upon. The most favourable moment for accurately measuring the pelvis is immediately after delivery, the patient being anæsthetised. No opportunity should be lost of taking measurements at this time in cases of contracted pelvis, so that previous diagnosis may be confirmed or corrected. For practical purposes a rough estimate of the transverse is also necessary in order to determine the shape of the pelvic brim. Photography by X-rays can be employed to show the *shape* of the pelvis with striking success except in advanced pregnancy. It is also possible by the accurate methods of radiography now practised to estimate the diameters of the brim with a fair amount of precision. Another useful method of control, however, exists in determining for any given case the

relation in size between the pelvis and the fœtal head. This can be done during pregnancy as well as in labour, and is usually employed in deciding upon the mode of treatment required in pelvic contraction. This method will be described in another place (p. 421).

Pregnancy and Labour in Contracted Pelves.—The course of *pregnancy* is not affected to any considerable extent by pelvic contraction. There is no greater risk of abortion, and only a slightly greater risk of premature labour, than when the pelvis is normal ; the development of the fœtus is not affected in any way, the full-time child being of average size and weight. Towards the close of pregnancy the uterus may become anteverted, causing a more or less marked condition of ' pendulous belly.' This is mainly due to the unusual height of the presenting part, which cannot enter the narrow pelvis ; the level of the fundus is consequently higher than usual, and when spinal curvature is associated with pelvic contraction the forward displacement of the uterus becomes very marked. Multiparity, with lax abdominal walls and diminutive stature, still further exaggerate the anteversion. Pelvic contraction has been already alluded to as an occasional cause of incarceration of the retroverted gravid uterus at the fourth month.

The general course of *labour* is modified by pelvic contraction in various ways :

(1) Abnormal presentations are three or four times commoner in contracted than in normal pelves ; the reasons for this have already been mentioned.

(2) Prolapse of the cord is much commoner than in normal pelves.

(3) When natural delivery occurs, labour is prolonged and the mechanism is modified.

(4) Unless the true conjugate is at least $3\frac{1}{4}$ inches, even with artificial aid the survival of the child is seriously jeopardised.

(5) The maternal risks are increased by the greater length and difficulty of the labour, and by the frequent necessity of employing artificial methods of delivery.

(6) The fœtal risks are increased in natural delivery by severe compression of the head during its passage through the narrow pelvis, and under other circumstances by the

operations required to effect delivery, some of which involve the destruction of the fœtus.

The *clinical phenomena* are modified in several important particulars. When the degree of obstruction is considerable, violent uterine action may be aroused, which may either pass into *tonic contraction*, or more rarely give place to *secondary inertia*. The cervix dilates slowly, and the first stage is therefore prolonged; the bag of waters is voluminous and frequently ruptures prematurely; great enlargement of the anterior lip of the cervix, from œdema, may occur from the compression of the lower uterine segment between the head and the pubes. A large caput succedaneum forms in vertex or face presentations; it may be so large as to present at the vulva before the head has passed the brim. In a rachitic flat pelvis the expulsion of the head through the vulva is often unusually rapid when the patient is a multipara; in the generally contracted pelvis it is always slow and difficult.

The shape of the pelvis and the length of the conjugate are the factors which chiefly influence the course of labour. With the three common varieties of contracted pelvis in cases which are allowed to go to term, spontaneous delivery occurs in from 40 to 63·3 per cent.; the simple flat pelvis is the most favourable in this respect, then the generally contracted pelvis, and lastly the rachitic flat pelvis. The frequency of spontaneous delivery at term diminishes rapidly in proportion to the diminution of the conjugate. Thus the Vienna statistics previously referred to show the following percentages:

C. V. . . .	$9\frac{1}{2}$ cm.	= (3·8 in.)	spontaneous	75·6 %
C. V. . . .	9 ,,	= (3·6 ,,)	,,	58·7 %
C. V. . . .	$8\frac{1}{2}$,,	= (3·4 ,,)	,,	49·7 %
C. V. . . .	8 ,,	= (3·2 ,,)	,,	25·0 %

Mechanism.—I. *Flat Pelvis.*—(*a*) In *head presentation* the mechanism is usually modified in the following manner, although many variations may be met with: The head enters the brim more or less extended, and in the transverse instead of the oblique diameter. Parietal obliquity is usually well marked in the second stage of labour. When the contraction of the conjugate is considerable, lateral displacement of the head towards the side occupied by the occiput occurs early in labour; this is rendered possible by

the increased length of the transverse diameter, and tends to promote flexion, because the sinciput is delayed in the

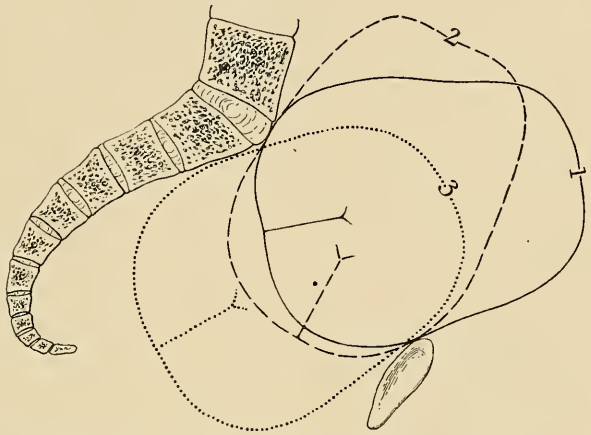


Fig. 220.—Labour in Flat Pelvis: Rotation of the Head in Passing the Brim. (Clarence Webster.)

1. Well-marked anterior parietal obliquity. 2. Forward rotation. 3. Backward rotation.

narrow conjugate, while the occiput, having more room, is free to descend. The result of this movement is that the bi-parietal diameter is brought into the wide lateral part of the brim, while the bi-temporal diameter engages in the conjugate. With anterior parietal obliquity the head passes through the brim by a movement of rotation round the *promontory* (Fig. 220). As it descends, the sagittal suture approaches the pubes, bringing the posterior parietal bone first into the cavity (Fig. 220 (2)). Rotation in the opposite direction next occurs, the sagittal suture approaching the sacrum (Fig. 220 (3)) and thus bringing the anterior parietal bone into the cavity. With posterior parietal obliquity at the commencement of labour, a similar movement of rotation round the *pubes* occurs. The mechanical advantage of this movement of rotation is indicated in

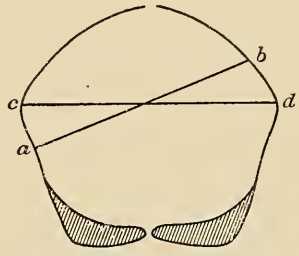


Fig. 221.—Wedge Shape of Fœtal Skull on Coronal Section. (Dakin.)

c—d. Bi-parietal diameter.
b—a. Super-sub-parietal diameter.

Fig. 221. The lateral inclination of the head which accompanies this movement tilts the bi-parietal plane *c*—*d*, and brings into the brim a plane the diameter of which is indicated by *b*—*a*. This is the super-sub-parietal diameter, measuring about a quarter of an inch less than the bi-parietal. The widest part of the head thus escapes direct engagement in the plane of the brim. Forward rotation of the occiput will occur if the head is flexed when it reaches the pelvic floor. When the head has passed the brim, there will be no further difficulty in delivery unless the shoulders are disproportionately large.

If the movement of lateral displacement does not occur, as labour proceeds the head may become completely extended, the posterior part being prevented from descending while the anterior part has sufficient space for this movement. This may result in a brow or face presentation.

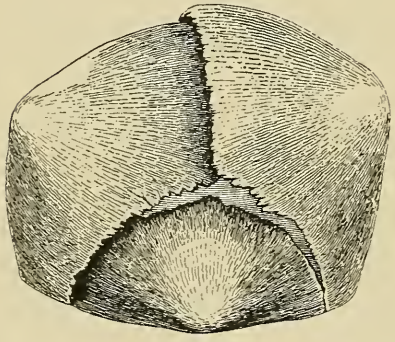


Fig. 222.—Posterior Aspect of Fœtal Skull: Extreme Moulding from Labour in Flat Pelvis. (Ribemont-Dessaignes and Lepage.)

The moulding of the fœtal head is modified; there is well-marked lateral asymmetry, the middle of the posterior parietal bone being much depressed; but in the longitudinal plane overriding of the bones is not excessive (Fig. 222). Often a depression or a depressed fracture of the posterior parietal bone is caused by the pressure exercised upon it by the promontory (p. 643). Or, after birth, a depression may be found upon the posterior parietal bone, which marks the line of compression by the promontory in the movements of lateral displacement and rotation round the sacrum.

(*b*) In *breech presentation* the mechanism of delivery of the after-coming head is modified as follows: The head engages with its occipito-frontal diameter in the long transverse diameter of the brim; a movement of lateral displacement, similar to that just described, should next occur,

and be followed by a movement of extension. Owing to the wedge shape of the fœtal skull on coronal section (Fig. 221), a certain mechanical advantage is obtained by the after-coming head, inasmuch as the narrow end of the wedge—*i.e.*, the base of the skull—first enters the brim. The bi-parietal diameter will therefore tend to be reduced somewhat by compression during its passage, and the difficulty will thus be diminished. It is probable, however, that this theoretical advantage is nullified by the fact that the after-coming head is not subjected to the process of moulding, which in a contracted pelvis is of especial importance, by adapting the shape of the head to the distorted canal through which it has to pass. Rotation round the promontory, bringing first the posterior, and then the anterior parietal bone into the pelvic cavity, will occur when the degree of contraction is considerable.

II. *Generally contracted Pelvis.*—In this form of contracted pelvis the mechanism of labour is not greatly modified, as the proportions of the pelvis are normal. In *head presentation* the movement of *flexion* is exaggerated, reducing the diameter of engagement to the utmost possible extent. *Internal rotation* is controlled by the *inclined planes of the ischium*, not by the pelvic floor. Upon the inner surface of the ischium a shallow ridge may be traced running from the ilio pectineal eminence to the ischial spine ; behind this line is a smooth bony surface, the *posterior ischial plane ;* in front of it is a similar surface, the *anterior ischial plane* (Fig. 107). When the head lies in the oblique diameter (first position) the occiput will come in contact with the left anterior plane, the sinciput with the posterior plane of the opposite side. The inclination of these planes is such that in contact with the anterior plane a body is directed forwards and inwards (towards the middle line), in contact with the posterior, backwards and inwards. The effect will therefore be to carry the head from the oblique into the antero-posterior, diameter. Forward rotation of the occiput will occur in the first and second positions, backward rotation in the third and fourth. Unless the head tightly fits the pelvis this effect will not be produced ; therefore it is only in the case of a generally contracted pelvis, or a normal pelvis with an abnormally large head, that it can be looked

for. It follows that backward rotation is the rule in occipito-posterior positions with a generally contracted pelvis and a head of average size. The passage of the head through the outlet is rendered unusually difficult by the diminution of the antero-posterior and transverse diameters of the lower pelvic strait. In this respect great difference exists between the flat and the generally contracted pelvis.

In *breech presentation* also the mechanism of labour is not appreciably modified, but, owing to the reduction in length of the diameters of the outlet, displacement of the arms is very frequent and the delivery of the after-coming head is unusually difficult ; for this reason breech presentation is very unfavourable to the fœtus in a generally contracted pelvis. If extension of the head should occur perforation will be unavoidable.

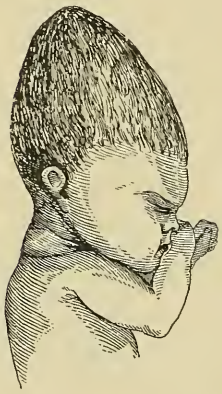


Fig. 223.—Extreme Head Moulding from Labour in generally contracted Pelvis. (Barbour.)

The moulding of the head is of the normal type, but is extreme in degree (Fig. 223) ; depression and fracture of the bones are, however, more uncommon than in a flat pelvis.

Labour is more difficult in a generally contracted pelvis than in a flat pelvis with an equal length of conjugate, for the reason that the former is contracted throughout, the latter only at the brim. In the flat pelvis all difficulty ceases when the head has passed the brim ; in the generally contracted pelvis the delivery of the head through the narrow outlet is the most difficult stage.

Management of Labour in Contracted Pelves

The size of the pelvis is the most important point to be considered in deciding upon the method of obstetric management to be applied to any individual case. The most important diameter to be considered is the conjugate of the brim,

and it is convenient to arrange cases of pelvic contraction in three groups according to the length of this diameter.

A. First Degree (C.V. 3½ to 4 inches).—It must in the first place be recognised that in this degree of pelvic contraction there is a fair prospect that delivery at term may occur either naturally, *i.e.* spontaneously, or with the aid of forceps. The chances of this favourable termination are greatest in the case of young women with their first three or four labours; in a primigravida the prospect is to some extent complicated by the difficulties usually associated with a first labour; it must, however, be added that pelvic contraction of the first degree frequently goes unrecognised in a first pregnancy, and is first suspected when difficulty in labour occurs. In the case of a multipara who has already had many children the prospect is also less favourable, for in such women the uterus has lost power, and is accordingly unable to accomplish that effective moulding of the fœtal head which is required if it is to pass safely through the narrow diameters of the pelvis. Unless the true conjugate diameter measures at least 3½ inches, labour at term very seldom terminates favourably, although occasional exceptions in which a fœtus of average size has passed through a narrower pelvis than this may be met with. In the case of a generally contracted pelvis 3¾ inches is a safer limit to adopt, as the difficulties are greater than in a flat pelvis.

The reports of Queen Charlotte's Hospital show that during the seven years 1905 to 1911 one hundred and seventy-six cases of pelvic contraction of this degree were delivered in the hospital without any maternal mortality, although with some increase of the rate of *puerperal morbidity* (see p. 545). Labour at term under these conditions frequently requires the assistance of forceps, for in one hundred and seven cases forceps were required, as compared with sixty-nine cases in which delivery was spontaneous. The fœtal risks are not serious in pelvic contraction when delivery is spontaneous: in the sixty-nine cases of natural delivery all the infants survived but one, which, though born alive, succumbed to injuries received during delivery, *i.e.* the fœtal mortality was 1·4 per cent. But among the one hundred and seven cases delivered by forceps, in seventeen

the child died either during labour or the first few days of life, giving a fœtal mortality for this method of delivery of 15·7 per cent.

From these considerations it is evident that when cases of pelvic contraction, in which the true conjugate is at least $3\frac{1}{2}$ inches, are allowed to go to term, labour requires judicious management, and resort should not be made to the use of forceps until it is quite evident that spontaneous delivery will not take place. Every opportunity should be given to the natural forces, by moulding to adapt the head to the abnormal shape and size of the canal through which it has to pass. There are two requisites for this process—viz., a strongly and regularly acting uterus, and a prolonged second stage. Prolonged moulding by the natural forces involves much less injury to the fœtus than the violence done by dragging an imperfectly moulded head through a contracted pelvis.

In all such cases the second stage of labour must be closely watched, and the mechanism studied with care. In the case of a flat pelvis the prognosis is considerably affected by the kind of parietal obliquity which is present ; in the anterior variety the mechanism appears to be easier, for such cases are more frequently delivered spontaneously, and are more favourable for forceps extraction than the posterior variety. The position of the sagittal suture accordingly becomes an important prognostic indication ; if this suture is found posteriorly when the head is detained in the pelvic brim the prognosis is favourable. The overlapping of the bones at the lines of suture should also be watched, and the more marked this change becomes, the better the prospect of safe delivery. When moulding is retarded by insufficiency of the contractions or by rigidity of the cranial bones, the passage of the head is rendered much more difficult. In a generally contracted pelvis well-marked parietal obliquity is unusual ; the head is generally well flexed, bringing the posterior fontanelle into a central position in the pelvis, and this point, together with overlapping of the bones from moulding, form the most important features.

A prolonged second stage is to be anticipated, and is indeed requisite for a successful result. In all cases three or four hours may be allowed, and in many instances this may

be considerably exceeded without any indication of 'fœtal distress' appearing. Careful observation of the strength and rate of the fœtal heart sounds should be made at frequent intervals. The formation of a large caput during this period is to be anticipated, and is not a sign of serious importance. Attempts to deliver the head by the high forceps operation (see p. 699) while the head is merely engaged or but imperfectly moulded are strongly to be deprecated; serious injury to the child's head is almost inevitably caused by this procedure. When it is evident that the head is descending and becoming well moulded, and there are no signs of fœtal distress, the use of forceps should be withheld as long as the mother can be encouraged to continue her efforts and there is no evidence of obstetric exhaustion. Should the advance of the head cease or the pains become ineffective, forceps must be employed. In the case of a flat pelvis, when the head has passed through the brim, forceps need no longer be withheld, as delivery through the cavity and outlet will be easy. In a generally contracted pelvis the expulsion of the head becomes increasingly difficult as the outlet is reached, and forceps should not be applied till the head has reached a lower level.

The special points requiring attention in forceps delivery through a contracted pelvis will be referred to in a later section.

B. Second Degree (C.V. 3 to $3\frac{1}{2}$ inches).—When the conjugate measures $3\frac{1}{2}$ inches or upwards, delivery by forceps can usually be effected when labour is conducted throughout in the manner described in the last section. In the case of pelves smaller than this failure with forceps is not uncommon, and the methods of delivery which may be practised after forceps has failed must next be considered.

If the child is dead it is obvious that a destructive operation may suitably be performed and the head delivered by craniotomy. Care must be exercised in deciding that death has occurred, for mistakes are not infrequently made. If the fœtal heart has been kept under observation during the second stage its cessation can be determined without hesitation; but if the heart has not previously been heard by the medical attendant, careful and repeated observation must be made before deciding that the heart-sounds have ceased.

Other signs of fœtal distress may be present which will lend support to this conclusion.

If the child is still alive the choice of the method of delivery next to be adopted is by no means an easy one, and somewhat sharp differences are to be met with in the practice of different schools of midwifery. The alternatives are delivery by Cæsarean section, and delivery through the natural passages by the aid of one of the operations designed temporarily to enlarge the pelvic canal—viz., symphysiotomy and pubiotomy or hebotomy. These procedures will be described in the section dealing with obstetric operations, and their relative merits cannot be discussed profitably until the methods of performing them have been considered. It may, however, be said that the maternal risk is not appreciably greater for one than for the other, and the chance of the ultimate survival of the child is better with Cæsarean section than with the other operation. In this country delivery by Cæsarean section is regarded with the greater favour, provided that there is reasonable security that the uterus has not been infected. When the conditions are such that it is likely that infection has occurred, all operative procedures are attended with serious maternal risks, and craniotomy must be considered even if the child is alive. In some Continental clinics and in Dublin pubiotomy is preferred to either Cæsarean section or symphysiotomy.

C. Third Degree (C.V. under 3 inches).—Delivery of a living and viable child is impossible through a pelvis so small as this. When the diagnosis of contraction of this degree is first made during labour, Cæsarean section should be performed at the earliest possible moment. If labour has already been prolonged and the child is dead, extraction by craniotomy can be performed in all but the most extreme cases (see p. 737).

Prophylactic Management.—Two prophylactic measures have been extensively practised to facilitate delivery in cases of pelvic contraction, viz., (1) *prophylactic podalic version*, and (2) *induction of premature labour*.

(1) *Podalic version* by the external or combined methods (see p. 672) has been practised in cases of *flat pelvis* for the theoretical reasons which have been already set forth in con-

sidering the mechanism of delivery of the after-coming head (p. 376). Experience of this method has, however, shown it to possess one great disadvantage, viz., that the necessity for haste in delivering the after-coming head renders it impossible for moulding to occur, and consequently considerable force may be required to extract it, causing serious injury to the head. The results as regards the fœtal mortality accordingly compare unfavourably with those obtained by delivery with forceps in the manner described above. In cases of flat pelvis it is better that breech presentations should be corrected before labour, as would be done if the pelvis were of normal size. Two advantages are gained thereby, viz., (1) a more accurate determination of the relative sizes of the fœtus and the pelvis can be obtained, and (2) the head presentation offers the better chance of delivering a living child.

In cases of generally contracted pelvis prophylactic podalic version should never be performed.

(2) *Induction of Premature Labour.*—The object of inducing premature labour in pelvic contraction is to avoid or diminish difficulty by arranging that labour shall come on at a time when the fœtus has not reached its full development, and accordingly the dimensions of the head are less than at term. This procedure is not attended by any appreciable maternal risk, but it involves the serious difficulty that premature infants are weakly and more difficult to rear, and often require skilled attendance for a long period after their birth. This difficulty is naturally more serious among the poor than among the well-to-do classes, but as the great majority of cases of pelvic contraction occur in women of the poorer classes the difficulty is undoubtedly a grave one.

Prophylactic induction must therefore stand or fall by the fœtal and infantile mortality which attends it; the procedure cannot be considered successful unless the infant not only survives its birth, but subsequently makes such progress as would give it a fair chance of life. In estimating the fœtal mortality of prophylactic induction, all cases in which the infant dies during the first fourteen days of life must be included, and there remains some doubt as to the exact proportion of infants which, being discharged, for

instance, from a lying-in hospital at the fourteenth to the twenty-first day, survive the first year of life. The later mortality, inasmuch as it could be very largely avoided by proper management, is not, strictly speaking, to be regarded as the outcome of the method of delivery.

The infant's chance of survival is influenced mainly by two factors—(*a*) the size of the pelvis through which it has to pass ; (*b*) the period of development which it has attained. To a great extent these are opposing factors, for although the smaller the fœtus the more easily it will pass through the pelvis, yet the smaller the fœtus the less chance has it of surviving. Experience of the operation shows that a premature infant of $4\frac{1}{2}$ pounds and upwards has an excellent chance of life ; this weight is attained under normal conditions at about the thirty-sixth week (p. 57). It follows that if the pelvis is large enough to allow a child of this size to be delivered without injury, induction of premature labour may fairly be expected to be successful. Further experience has shown that unless the conjugate diameter measures at least $3\frac{1}{2}$ inches ($3\frac{3}{4}$ inches in a generally contracted pelvis), the risk of injury to the child during delivery is so great as to contra-indicate induction. Therefore it may be said that prophylactic induction is most likely to be successful when pregnancy has advanced as far as the thirty-sixth week and the conjugate of the brim measures at least $3\frac{1}{2}$ inches.

In the case of a pelvis with a conjugate definitely exceeding $3\frac{1}{2}$ inches there is good prospect of the successful delivery of a living child at term. Under these circumstances labour need not be induced in a first pregnancy, but if there is a history of previous difficulty and loss of the child during labour, induction may be practised.

Having decided that a case is a suitable one, as regards the size of the pelvis, for treatment by prophylactic induction, the selection of the proper time for interference requires very careful consideration. This cannot be settled by definite rules, for while a fairly correct estimate of the size of the pelvis can be made by clinical measurements, this is not the case with the fœtal head. The size of the fœtus at a given period of pregnancy is not constant, and some women habitually bear children of abnormally large size. Accord-

ingly the proper time for induction cannot be determined by dates and pelvic measurements alone.

In every case it will clearly be of advantage to the child to allow pregnancy to continue as long as possible, and it therefore becomes necessary to form an estimate, as accurate as possible, of the relation between the size of the pelvis and that of the fœtal head. Direct measurements of the head *in utero* cannot be made, and the method adopted is to deter-

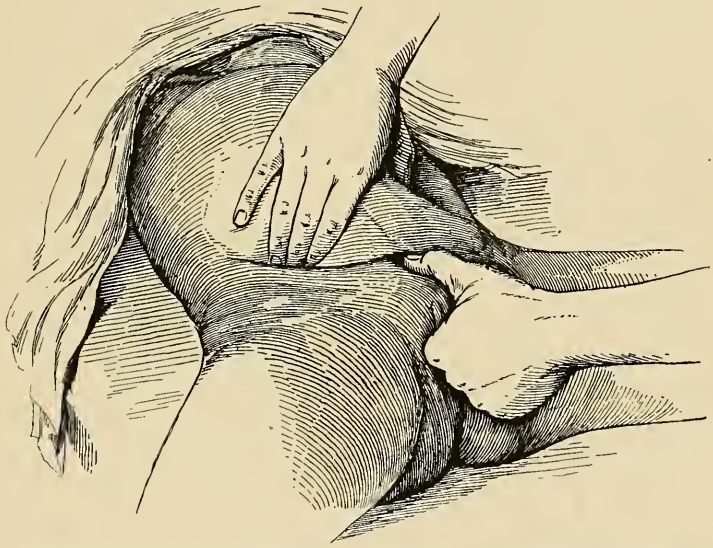


Fig. 224.—The Bi-manual Method of Estimating the Relative Sizes of the Fœtal Head and the Pelvic Brim. (Munro Kerr.)

mine from time to time that the head is not too large to be pushed down into the brim of the pelvis.

This estimation may be made by the *external* or the *combined* method. In either case the head must, of course, be presenting ; external cephalic version must therefore be first performed if the presentation is abnormal. In stout women it is difficult to get a satisfactory result even under anæsthesia. In the *external* method the patient lies upon her back with the shoulders slightly raised upon pillows. The head is then located, and seized by the two hands in the ' first pelvic grip ' described on p. 313. Grasped between the two hands the head is then pushed steadily down and

back into the pelvis. A little experience is required to obtain a convincing result, and the procedure is much more easily carried out under anæsthesia, which, however, must be pushed to the point of complete muscular relaxation. The combined or bi-manual method illustrated in Fig. 224 is that of Müller as modified by Munro Kerr ; this also can be much more easily carried out under anæsthesia. The patient lies at the edge of the couch in the modified lithotomy position, the legs supported by assistants or in a Clover's crutch. Two fingers of the left hand are then passed into the vagina into contact with the head at the brim ; the thumb is passed in front of the pubes so as to feel the upper part of the head through the abdominal wall. With the right hand the head is then pushed down into the pelvis, its descent being observed by the fingers and thumb of the left hand. Pressure upon the fundus by an assistant is sometimes also required. It is thus possible, in a favourable case, to determine whether the greatest diameter of the head can be made to pass into the brim.

Another method of estimating the relation between the size of the head and that of the pelvis has been introduced recently by von Herff. He measures the distance between the fifth lumbar spine and the most prominent part anteriorly of the child's head. If this is equal to or less than the external conjugate, the head will enter the brim without difficulty. If it is 1 cm. longer than the external conjugate, delivery may be effected spontaneously with the aid of Walcher's position (p. 711). If the excess is 3 cm. or more, the case will present very considerable difficulty.

The first estimation by these methods should be made not later than the thirty-fourth week. If it is found that the greatest diameter of the head then passes easily into the pelvis pregnancy may be allowed to continue for another week, when the manœuvre is to be repeated. As soon as difficulty is experienced in depressing the head into the brim labour should be induced. A certain amount of reduction in size may be confidently anticipated from moulding during labour.

Before definitely undertaking induction for pelvic contraction, an examination under anæsthesia should be made, the diagonal conjugate being carefully measured, and

estimation made by the combined method of the relative sizes of the head and the pelvis.

Prophylactic induction is extensively practised at Queen Charlotte's Hospital under the conditions described above. In 10,000 labours there were 206 cases of induction ; among these there was no maternal mortality, but 26 of the infants did not survive ; the remainder all left the Hospital doing well between the twelfth and twenty-eighth days. The maternal mortality was therefore *nil*, the combined fœtal and infantile mortality 12·6 per cent. Von Herff has recently published statistics from the University Clinique of Basle which show a fœtal and infantile mortality of 20 per cent., calculated on a series of 120 consecutive prophylactic inductions, the method of induction employed being rupture of the membranes. Under carefully selected conditions it may therefore be considered that this procedure will be successful in upwards of 80 per cent. of cases.

A premature, induced labour is to be conducted on the same principles as those laid down for labour at term in contracted pelvis. Instrumental interference should not be required in more than 15 per cent. to 20 per cent. of cases, and forceps delivery should never be resorted to at an early stage, for there is no doubt that extraction with forceps is more likely than a prolonged second stage to do harm to the child.

Rare Forms of Contracted Pelvis

A. Due to disease affecting the skeleton generally.
   (1) *Osteomalacic pelvis.*
   (2) *Pseudo-osteomalacic pelvis.*
B. Due to disease of the pelvic joints.
   (3) *Nägele's* or *Oblique pelvis.*
   (4) *Robert's* or *Transversely contracted pelvis.*
   (5) *Oblique pelvis* due to disease of the hip-joint.
C. Due to disease of the vertebral column.
   (6) *Funnel pelvis ; Kyphotic pelvis.*
   (7) *Scoliotic pelvis.*
   (8) *Spondylolisthetic pelvis.*
D. Due to tumours of the pelvic bones.

(1) *Osteomalacic Pelvis* (Malacosteon Pelvis, Triradiate

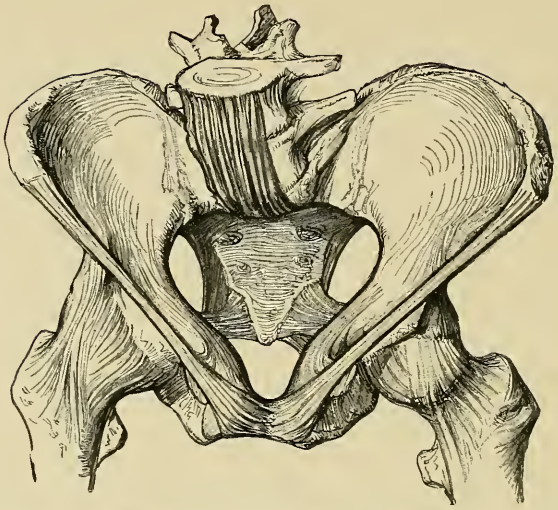


Fig. 225.—Osteomalacic Pelvis with Moderate Deformity.

Pelvis).—Osteomalacia, or mollities ossium, produces a characteristic pelvic deformity shown in Figs. 225 and 226. The softening produced by this disease weakens the pelvic bones so much that they yield to pressure in all directions, with the result that the pelvis collapses and entirely loses its shape. The lateral pelvic walls fall in, this change becoming first apparent in relation to the anterior part of the brim in front of the acetabula (Fig. 226). This produces the characteristic ' beaking ' of the pubes. As the deformity

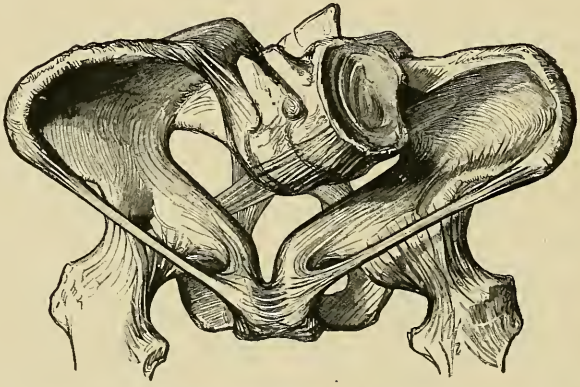


Fig. 226.—Osteomalacic Pelvis: Advanced Deformity.

progresses the pelvic walls may come almost in contact with one another in their anterior parts. The sacrum becomes displaced forward, the spine is curved, the beaking of the pubic bones increases, the iliac crests become twisted, and extreme deformity results, the pelvic brim being reduced to a triradiate slit (Fig. 226). In addition to the changes in the pelvis, marked deformity of the long bones and of the verte-

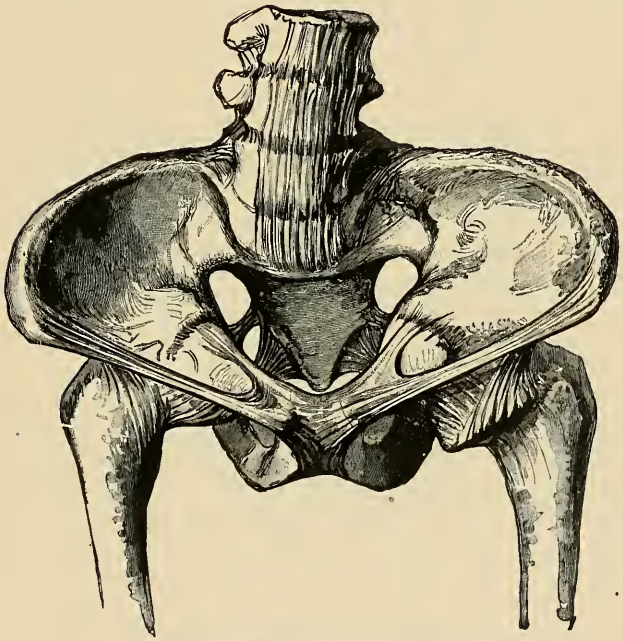


FIG. 227.—Pseudo-osteomalacic Pelvis.

bral column occurs. Extreme degrees of pelvic contraction are caused by this disease.

It has been found that removal of the ovaries sometimes arrests the morbid process in the bones, and in consequence Cæsarean section, followed by removal of the uterus and ovaries, has been advocated as the best treatment during pregnancy. Cure of existing deformity is of course impossible, but in a certain proportion of cases the advance of the disease has been arrested by this operation. Abortion may be induced in the early months as an alterative to the radical and curative operation.

(2) *Pseudo-osteomalacic Pelvis.*—This variety is due to rickets, and has received its name from the resemblance it presents to osteomalacic contraction (Fig. 227). The pubic bones are slightly beaked, but the lateral pelvic walls have not yielded to the same extent as in the former variety. The anterior portions of the iliac crests are not normally incurved, so that the interspinous equals or exceeds the intercristal diameter in length. Severe rickets is the cause of the deformity, and general rachitic changes in the skeleton are always associated with it. Treatment in pregnancy is

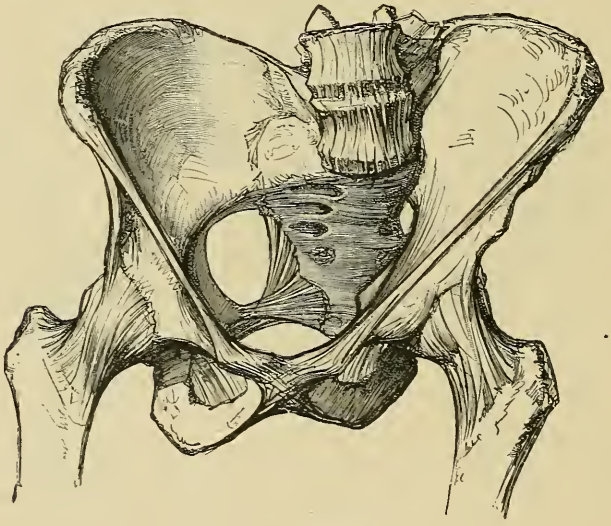


Fig. 228.—Nägele's Pelvis.

governed entirely by the degree of contraction present. The recognition of this and the foregoing variety is facilitated by the obtrusive signs of general bone disease which accompany them.

(3) *Nägele's Pelvis.*—This variety is caused by disease occurring in infancy, in or near *one* of the sacro-iliac synchondroses ; as a result ankylosis with bony union of the joint occurs, and the development of the ala of the sacrum on the affected side is more or less completely arrested. The resulting deformity is shown in Fig. 228. On the affected side the ilio-pectineal line is almost straight, and the great sacro-sciatic notch is much narrower than its fellow. The

symphysis pubis is displaced for $\frac{1}{2}$ inch or more to the sound side of the mesial plane of the body. The oblique diameter of the sound side (the right in Fig. 228) is considerably diminished in the whole pelvis from brim to outlet; the opposite oblique, the transverse and antero-posterior diameters, are little affected; from narrowing of the sacro-sciatic notch, the sacro-cotyloid diameter (promontory to back of acetabulum) of the affected side is very considerably less than its fellow. The distance between

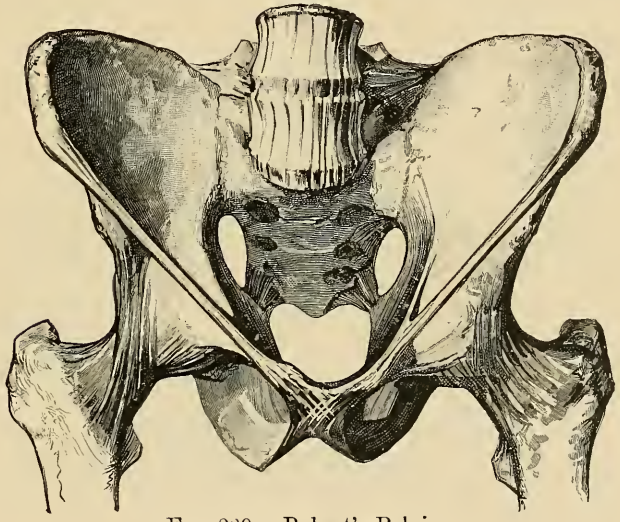


Fig. 229.—Robert's Pelvis.

the posterior superior iliac spines is reduced, and the pubic arch is asymmetrical.

The diagnosis of this form of contracted pelvis is difficult. The patient is usually well developed, and may show no sign of lameness, or of general bone disease. The oblique and sacro-cotyloid diameters are very difficult to measure clinically, and, as we have seen, the diameters which can be estimated are not greatly affected. The flattening of the lateral pelvic wall on the affected side can be recognised by careful digital examination under anæsthesia, and the lateral displacement of the symphysis pubis is a valuable indication of the condition. An *x*-ray photograph of the pelvis is the best method of diagnosis. Labour will be difficult, as the

diminution in the area of the pelvic brim and cavity is considerable.

(4) *Robert's Pelvis.*—This form of pelvis is due to *bilateral* synostosis of the sacro-iliac synchondroses, occurring in infancy ; the lesion is the same as in Nägele's pelvis, but it affects both joints (Fig. 229). The ala of the sacrum is imperfectly developed upon both sides ; both ilio-pectineal lines are nearly straight ; both sacro-sciatic notches are diminished in width. The result is a marked diminution in the transverse diameter of brim, cavity, and outlet of the

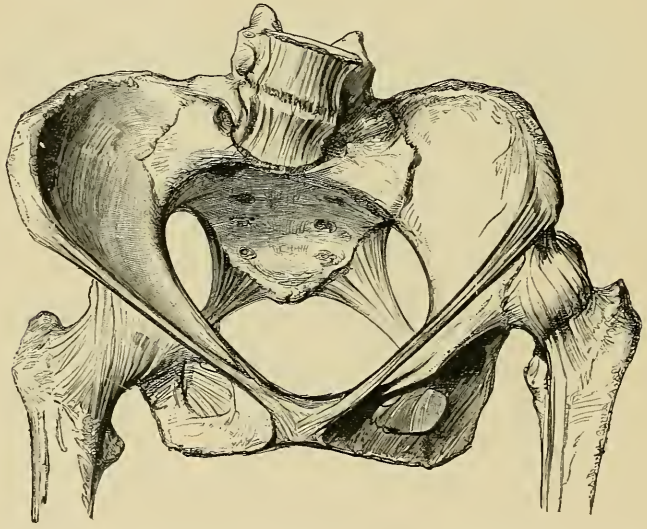


Fig. 230.—Oblique Pelvis due to Congenital Dislocation of Left Femur.

pelvis ; the pubic arch also is narrowed. The distance between the posterior superior iliac spines is considerably reduced. Diagnosis is easier than in Nägele's pelvis, as the transverse diameters of the brim and the outlet can be more readily estimated than the oblique.

(5) *Oblique Pelvis due to disease of the hip-joint.*—Various forms of oblique deformity may be produced by subluxation of the hip (which may be uni- or bi-lateral, congenital or infantile) and by caries of the joint. Spinal curvature is almost always associated with these lesions. The resulting lameness and deformity will direct attention to the condition

of the pelvis. In Fig. 230 it will be seen that there is well-marked tilting of the pelvis, and the flattening of the lateral pelvic wall affects the sound side, reducing the length of the left oblique diameter.

(6) *Funnel-shaped Pelves.*—In this form the important changes are found at the pelvic outlet, which is contracted in both its transverse and antero-posterior diameters. In consequence of the transverse contraction, the pubic arch is also narrowed. The funnel pelvis has recently been carefully studied by Whitridge Williams, who found that

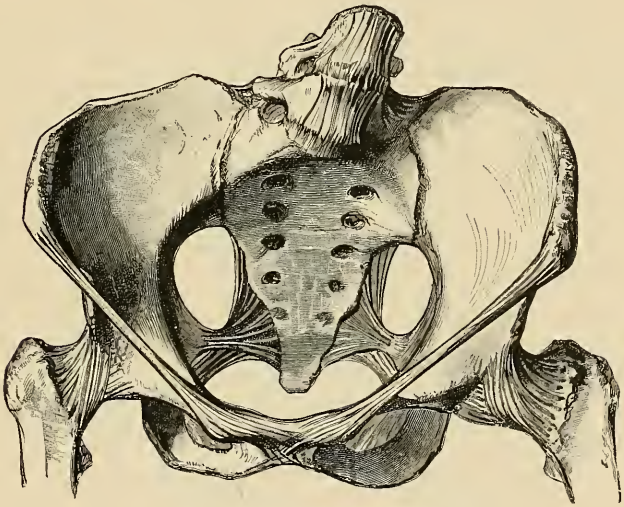


Fig. 231.—Kyphotic Pelvis.

in Baltimore this form of contraction is fairly frequent; he measured the pelvic outlet in 2,215 consecutive cases, and found it contracted in 135, *i.e.*, a proportion of 6·1 per cent. There are no similar statistics for this country, and those from Continental clinics are contradictory.

Williams describes two varieties of the funnel pelvis—the *simple* and the *complex*. In the *simple* funnel pelvis the measurements of the false pelvis and of the upper pelvic strait are normal; contraction of the outlet is the only change. In the *complex* variety changes occur in other parts than the outlet; thus the pelvis may be generally contracted, flat, or rachitic; or the spine may show angular

curvature due to old-standing caries, a variety of funnel pelvis to which the name of *kyphotic* is usually applied. Fairly conclusive evidence has been adduced that the simple funnel pelvis is caused by *lumbo-sacral assimilation, i.e.,*

Fig. 232.—The Sacrum and Lumbar Vertebræ from a Case of Spondylolisthesis. (Neugebauer.)

by fusion of the fifth lumbar and first sacral vertebræ, so that the sacrum consists of six pieces instead of five.

Diagnosis of contraction of the outlet may be made by palpation of the pubic arch and measurement of the transverse and antero-posterior diameters in the manner described on p. 404. When the transverse diameter is as low as $3\frac{1}{4}$ inches (8 cm.) and the antero-posterior diameter as low as $3\frac{1}{2}$ inches (9 cm.) a diagnosis of funnel pelvis is certain (Williams).

Labour is not affected by the simple funnel pelvis until the head reaches the pelvic outlet, when an insuperable obstacle to delivery may be encountered, if the degree of contraction is considerable—transverse diameter below $2\frac{3}{4}$ inches. In the complex varieties labour will be affected by the other pelvic changes. If forceps fails to deliver the head through a contracted outlet, craniotomy should be performed if the child is dead, pubiotomy if it is alive. Williams has shown that the latter operation is especially useful under these conditions, as the effect upon the outlet of division of the pubic bone is very marked. Cæsarean section is unsuitable except in the rare instances in which the contraction of the outlet may have been recognised early in labour.

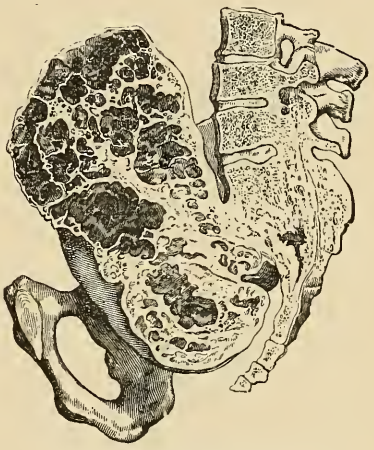


Fig. 233.—Sacral Exostosis. (Galabin.)

(7) *Scoliotic Pelvis.*—Lateral curvature of the spine may produce a certain amount of asymmetry of the pelvis, one side being somewhat more roomy than the other. Only slight degrees of pelvic contraction can, however, be produced in this way. When associated with rickets, scoliosis may produce an extreme degree of oblique deformity associated with flattening.

(8) *Spondylolisthetic Pelvis.*—This extremely rare form of pelvic contraction is due to forward dislocation from caries of the body of the fifth lumbar vertebra (spondylolisthesis—σπόνδυλος, vertebra; ολίσθησις, gliding). The lumbar vertebræ become displaced, descend into the pelvis, and of course greatly diminish the available length of the conjugate diameter (Fig. 232). In addition the pelvic outlet is diminished by forward displacement of the lower part of the sacrum and the coccyx. The resulting deformity of the spine is obvious, and on vaginal examination the displaced lumbar vertebræ can be recognised.

(9) *Tumours of the Pelvic Bones.*—Exostoses, either single or multiple, are sometimes found in the pelvis, the

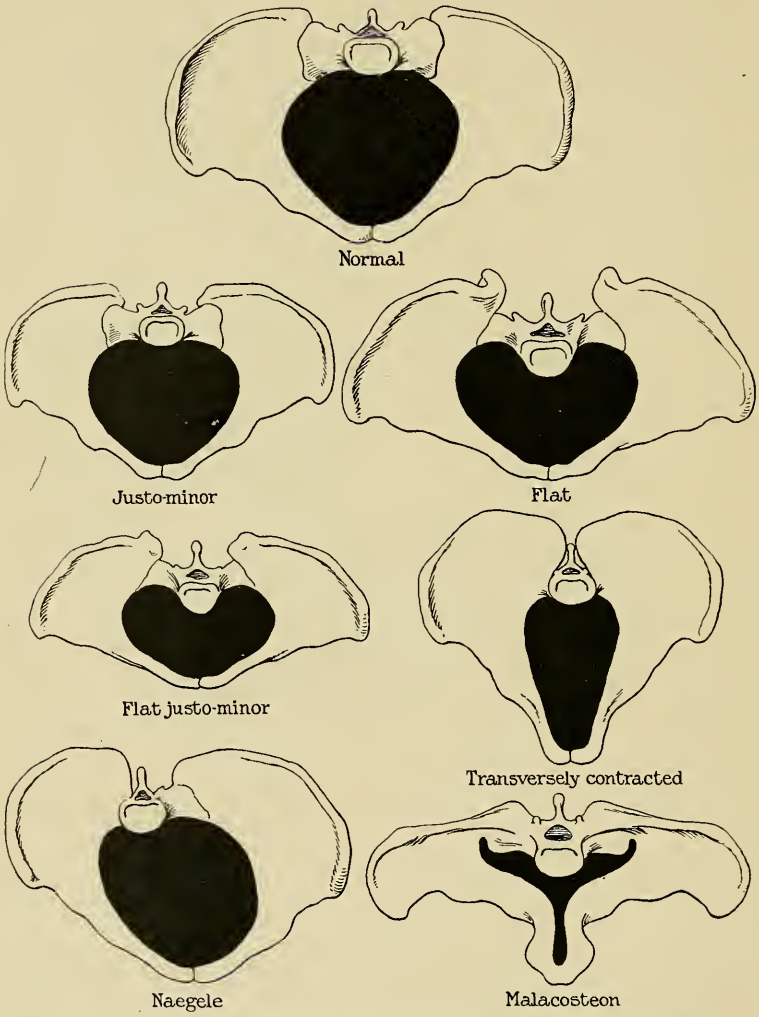


Fig. 234.—The Outline of the Pelvic Brim in the Principal Varieties of Contracted Pelvis. (Bumm.)

commonest positions for them being the anterior surface of the sacrum (Fig. 223) and the posterior surface of the pubes. In the latter position a small exostosis which has been overlooked may cause unexpected difficulty in labour.

Cartilaginous or sarcomatous growths of large size are sometimes met with, and may cause insuperable obstruction to delivery.

Abnormal Conditions of the Soft Parts

Ovarian Tumours.—When situated entirely *above the pelvic brim*, these tumours do not give rise to much difficulty in labour, even though of very large size. They may occasion some exaggeration of uterine obliquity, and thus lead to abnormal presentations ; but in this situation they never cause obstruction. Axial rotation of the tumour, leading to serious consequences, may occur either during pregnancy or in the puerperium. The diagnosis of a large ovarian tumour in the *abdomen* as a rule is not difficult during labour ; the differential diagnosis of hydramnios has been already referred to (p. 160). Operative treatment is rarely called for in labour, and should be postponed until the patient is convalescent, unless acute symptoms arise during the puerperium.

When situated *wholly* or *partially* in the *pelvic cavity*, ovarian tumours cause serious obstruction in labour ; they then lie below the presenting part and prevent the descent of the fœtus, and its passage through the outlet (Figs. 45 and 235). Spontaneous delivery, although very rare, may occur in the following ways : (1) the tumour, if cystic, may be ruptured by compression, and the collapsed cyst may then be too small to prevent the passage of the fœtus ; (2) the tumour may rupture the pelvic floor and be expelled in front of the presenting part, either through the anus or the vulva ; in such cases the pedicle of the tumour may be torn completely across, so that when expelled, the tumour is entirely free from its attachments. If the obstruction proves insuperable and is not artificially relieved, rupture of the uterus will occur.

The *diagnosis* of the presence of a *pelvic tumour* is easy during labour ; but fibroid and ovarian tumours are often mistaken for one another, for under continuous pressure a cystic tumour becomes tense and its walls œdematous, so that its consistence appears to be that of a soft solid mass, while fibroid tumours lose their naturally hard consistence

during pregnancy. Unless the head is fixed in the pelvic brim or the tumour is adherent it is generally possible, under anæsthesia, to push the tumour past the presenting part above the pelvic brim, where it will cause no further trouble for the moment; but if reposition is impossible from adhesions, or from any other cause, the best treatment is immediate *ovariotomy*. The alternative method of delivery by forceps or craniotomy, after tapping the tumour, is not

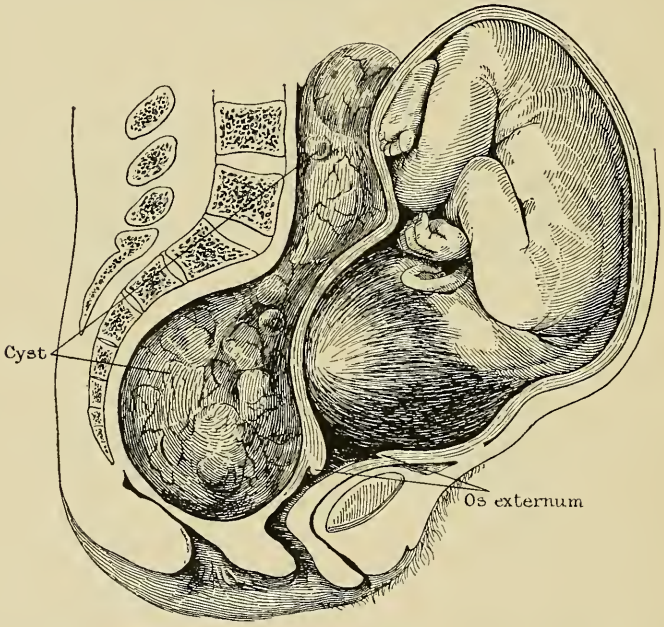


Fig. 235.—Ovarian Cyst obstructing Labour; Partial Dilatation of the Cervix has occurred. (Bumm.)

to be generally recommended, for so much injury is caused to the tumour in dragging the body of the fœtus past it that peritonitis from bruising and rupture frequently ensue in the puerperium, occasioning a high maternal mortality. In exceptional cases it may, however, be the safest expedient to adopt, as, for instance, when the unfavourable surroundings of the patient render the performance of an abdominal operation unduly dangerous. In such cases the collapsed tumour should be removed within two or three days after labour.

Ovariotomy during labour should be performed by the abdominal route; special care must be taken in securing the vessels, and this is much more difficult by the vaginal route. If the tumour is adherent in the pouch of Douglas it may be necessary to make a very long incision, and turn the uterus out of the abdomen in order to allow room to deal with the tumour. Or the child may first be delivered by Cæsarean section in such cases. The best time to perform the operation is towards the end of the first stage, for the cervix being dilated, the child can be delivered with forceps by an assistant as soon as the tumour has been removed. If performed in time, the prognosis is good both to mother and child, although ovariotomy in labour is, of course, more serious than in pregnancy.

Uterine Tumours.—The two commonest forms of uterine tumour—fibromyoma in the body, and cancer in the cervix—are not infrequently encountered in connection with pregnancy.

The influence exerted by *uterine fibroids* upon labour is governed almost entirely by their position. Those which occupy the lower uterine segment, or any part of the cervix, even when of comparatively small size, cause serious obstruction to delivery; this results partly from their bulk, but mainly from the fact that they prevent the normal dilatation of these parts during labour. It is not easy, before labour commences, to tell whether a fibroid tumour situated in the lower part of the uterine body will cause obstruction or not, for such tumours, when they do not encroach upon the lower uterine segment, may, by the action of the uterus, become drawn up into the pelvis as labour proceeds, so as not to hinder the birth of the child. Fibroids of the uterine body which are *interstitial* give rise to mal-presentation and irregular uterine action, and sometimes cause post-partum hæmorrhage by interference with muscular retraction. *Sub-peritoneal* fibroids, as a rule, exert no effect whatever upon labour; but when growing from the lower part of the posterior uterine wall they may become incarcerated in the pouch of Douglas, and give rise to the most serious obstruction (Fig. 236). Fibroids in any position are liable to become infected in the puerperium if the sterility of the uterine cavity is not maintained. A uterus which contains a

fibroid tumour is, however, not more likely to become infected during or after labour than one which does not. Fibroids are also liable to undergo certain degenerative

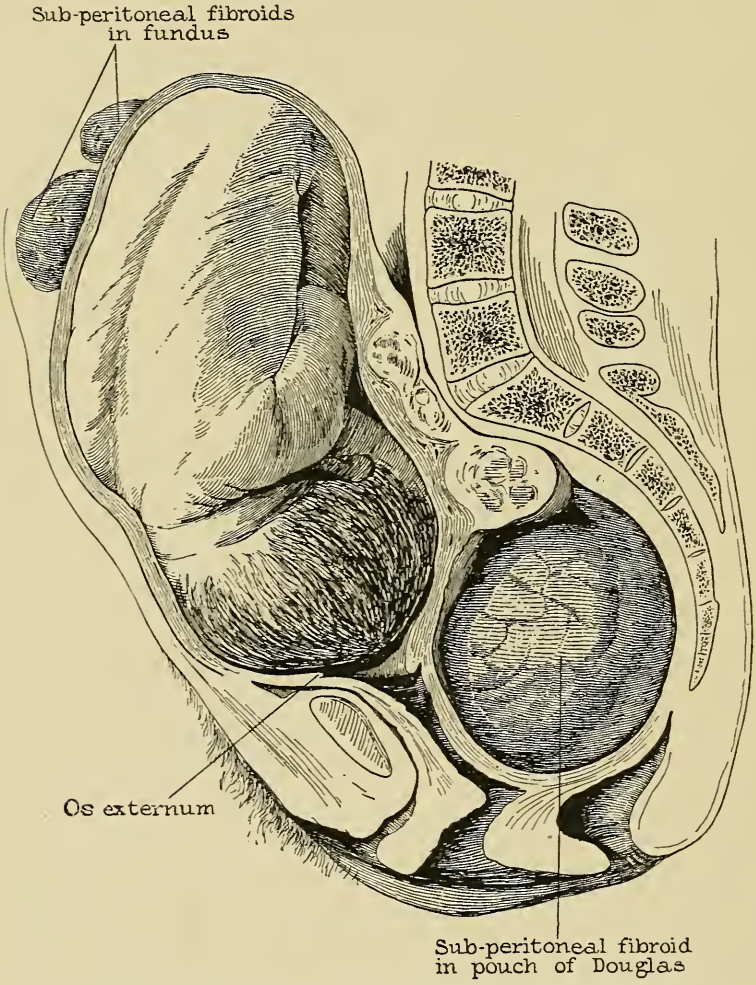


FIG. 236.—Labour obstructed by a Fibroid Tumour; Cervix partly dilated. (Bumm.)

changes, apart from infection, during the puerperium. *Fibroid polypi* have no influence upon labour, but may become detached and expelled during labour or in the puerperium.

Treatment turns entirely upon the question of obstruction. If it is clear that there will be insuperable obstruction, the best treatment is to allow pregnancy to continue and perform Cæsarean section at or near term (p. 721), which may be followed either by hysterectomy (removal of the uterus) or myomectomy (removal of the fibroid). It can seldom be said, however, before labour that insuperable obstruction will result, except in the case of interstitial cervical fibroids, and sub-peritoneal fibroids which have become incarcerated in the pouch of Douglas. Fibroid tumours situated in the body of the uterus tend in all cases to become displaced upwards as pregnancy advances and the growth of the uterus progresses. In this way a tumour which is found in early pregnancy to occupy the pouch of Douglas, in a position likely to give rise to serious obstruction, may be drawn up above the pelvic brim before term is reached. In its new position obstruction to labour is not necessarily caused at all, and natural labour may be awaited so long as the circumstances permit of the adoption of suitable operative measures should difficulty arise. Labour in a fibroid uterus always gives rise to a certain amount of anxiety, but the actual degree of difficulty which may be met with is not easy to foretell. The Cæsarean operation, should it prove necessary, may in such cases be performed with perfect safety if there has been no previous interference. The induction of abortion for an obstructing fibroid tumour is a difficult and dangerous operation, for it may prove impossible to secure adequate dilatation, making the evacuation of the uterine cavity a matter of extreme difficulty. In consequence, this procedure is not to be advised.

Cancer of the Cervix.—Advanced cancer of the cervix is one of the most serious complications of labour which can be met with. Owing to the loss of the normal resilience of the tissues, dilatation is impossible, and spontaneous delivery can only occur after extensive laceration. The puerperium may then terminate fatally from infection through sloughing of the lacerated tissues. Treatment consists in delivery by Cæsarean section, followed by supra-vaginal amputation of the uterus through healthy tissue ; when the child is dead it may be delivered by craniotomy if sufficient dilatation can be secured to render this practicable.

Early cancer of the cervix often does not prevent delivery *per vias naturales;* pan-hysterectomy should then be performed early in the puerperium. The treatment of cancer of the cervix in pregnancy has been referred to on p. 217.

Rigidity of the Cervix.—The term 'rigidity,' as applied to the cervix during labour, has a strictly conventional significance, and may be understood to include all the conditions in which dilatation is retarded. In one class of cases the cervical tissues are to all appearances healthy, although dilatation is slow or incomplete; this condition is called *functional rigidity* of the cervix. In another class some morbid condition of the cervix is present, to which the fault may be attributed; this is called *organic rigidity.*

(1) *Functional rigidity* is met with in primiparæ much more frequently than in multiparæ. It may arise from irregular or weak uterine contractions in the first stage of labour (*primary inertia*); from premature rupture of the membranes resulting in loss of the natural cervical dilator—the bag of waters; from morbid adhesion of the membranes in the lower uterine segment, preventing the formation of the bag of waters; from an unusual density of the cervical tissues, met with, as is believed, in elderly primiparæ (over thirty years); from œdema of the cervical tissues induced by compression when the pelvis is contracted, or when in a normal pelvis the vertex is extended; and possibly, in the last place, from spasmodic contraction of muscular fibres in the cervix. It will be seen that some of these conditions are in reality abnormalities in the mechanism of dilatation.

The clinical result of functional rigidity of the cervix is prolongation of the first stage of labour, which may be delayed for many hours or even for a day or two. The mother is then, naturally, greatly fatigued, but in other respects the maternal consequences are not serious.

As long as the membranes remain unruptured there is little risk to the fœtus. Clinically speaking, cases may be divided into two groups: those in which the pains are weak, and those in which the pains are strong. In the former primary uterine inertia (see p. 443) is also present, and is an important factor in causing the difficulty in dilatation; in the latter the uterine action is normal.

Treatment depends in the main upon the cause. If the

action of the uterus is at fault, the treatment is that of primary uterine inertia. On the other hand, if the pains are strong, repeated inhalations of chloroform sufficient to produce only slight anæsthesia, and the administration of chloral or bromide in repeated small doses, are useful remedies. But the most useful of all is the hypodermic injection of scopolamine and morphine, as described on p. 444. In the spasmodic variety, it is said that local application to the cervix of a 10 per cent. solution of cocaine is useful, but the recognition of this variety is difficult. If these means are unsuccessful, dilatation must be assisted, and as this involves very little risk to the mother it should not be postponed until she is tired out. If the external os is about two-thirds dilated and the head presents, the patient should be anæsthetised, dilatation completed by the fingers, and forceps at once applied. In a breech presentation a leg should be pulled down. If, however, the cervix is less than two-thirds dilated, a de Ribes' bag should be introduced: this will dilate the cervix in an hour or two and delivery can then be effected.

(2) *Organic rigidity* of the cervix may be due to adhesion of the lips of the os externum to one another, to small size of the os externum (*pin-hole os*), to hypertrophic elongation of the cervix, to cicatrices, or to the presence of a small cystic or solid cervical tumour. Fibroid and malignant cervical tumours, already considered, may also be regarded as causes of organic rigidity. *Small size of the os externum* in a primipara sometimes leads to a curious form of partial dilatation of the cervix, in which the whole of the cervical canal becomes fully opened up except the os externum itself. The head descends low into the vagina, the wall of the cervix is tightly stretched over it, and may be mistaken for the unruptured bag of waters if the small aperture representing the os, and situated upon the lowest part of the bulging swelling, should be overlooked. If in such a case the uterine pains are strong, transverse rupture of the anterior wall of the cervix may occur (Fig. 237). *Small tumours* should be dealt with by *removal;* the other conditions may be treated either by *incision* or by some method of *artificial dilatation.* Incision is probably the best treatment for all but hypertrophic elongation, which must be dealt

with by artificial dilatation. In performing this small operation an anæsthetic will not be required unless the patient is unusually nervous; a Sims speculum should be passed to expose the cervix, and with scalpel or scissors two deep incisions should be made through the cervical tissues at the sides of the os, one passing backwards and to the left, the other backwards and to the right. An interval of

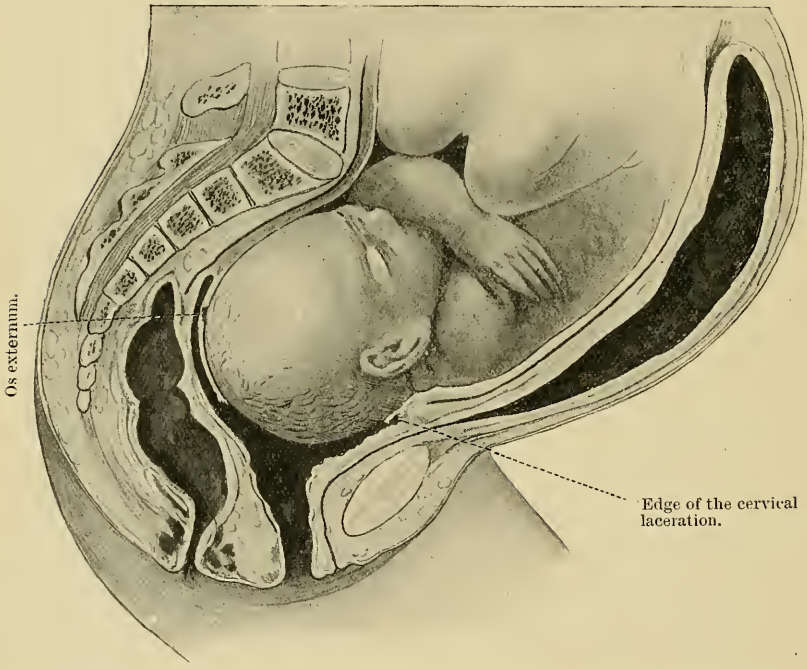


FIG. 237.—Transverse Laceration of the Anterior Cervical Wall and Non-dilatation of the Os Externum. (Diagrammatic from a case at Queen Charlotte's Hospital.)

an hour or two should be allowed in order to see if the uterine contractions will now complete the dilatation naturally. If this does not occur the dilatation should be completed with the fingers, under anæsthesia, and forceps applied. If cicatrices are present, the incisions should be made through the cicatricial tissue, and dilatation should then be allowed to proceed naturally. The same methods of artificial dilatation may be employed as in the case of functional rigidity.

Rigidity of the Pelvic Floor.—In elderly primiparæ (over thirty) the perineal body and the other tissues composing the pelvic floor appear to be deficient in elasticity, and consequently dilatation of the vulva at the end of the second stage does not proceed normally. The head may therefore be delayed for a long time upon the pelvic floor, slightly distending the vulva with each pain, but unable to escape ;

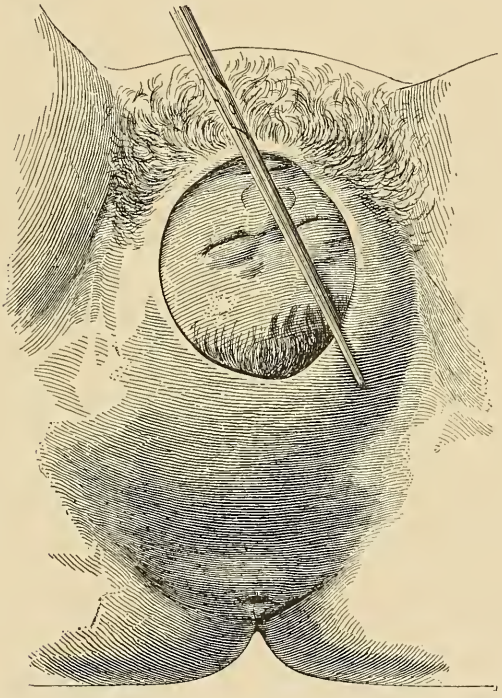


Fig. 238.—Episiotomy in a Face Presentation. (Edgar.)

unless the uterine contractions are unusually powerful, forceps will be required to extract it. On the other hand, if the uterine action is violent, the head will be driven by great force through the undilated vulva, causing a serious perineal laceration. Occasionally in such cases the vulva does not dilate at all, and a laceration then occurs in the perineal body between the fourchette and the anus, through which the head and body of the child escape. This is termed *central* or *intra-perineal* rupture. It is not always mesial in

position, and the latter term is therefore preferable. Attention must be paid in all such cases to the proper management of expulsion, and time allowed for the perineum to stretch. If a tear appears to be inevitable, two lateral incisions may be made in the anterior edge of the perineum (episiotomy); when tearing occurs it will then follow the lines of these incisions and be directed backwards and outwards away from the rectum, thus avoiding the risk of lacerating the sphincter ani (Fig. 238).

Abnormalities in the Action of the Uterus

Precipitate Labour.—Cases are occasionally met with in which labour proceeds so rapidly as to disturb the normal mechanism, the stages of dilatation and expulsion occurring simultaneously, or being indistinguishable from one another. After only two or three violent pains have been felt the child may suddenly be expelled, and be followed immediately by the after-birth; the whole process thus apparently occupying only a few minutes. It is difficult, however, in such cases to eliminate an element of uncertainty—viz. the possibility that uterine contractions, painless but effective, have been in progress unobserved by the patient, and have effected the usual dilatation; the violent pains which suddenly ensue thus representing only a precipitate second stage. The conditions which lead to precipitate labour are excessive force of the uterine contractions, and diminished resistances in the pelvis. Nothing is known of the causes of the former; but as instances of the latter may be mentioned the justo-major pelvis, and the relaxed or lacerated condition of the cervix and pelvic floor, often met with in multiparæ.

Precipitate labour is unfavourable both to the mother and the child. Rapid exhaustion of the uterus leading to post-partum hæmorrhage may occur, or the process of uterine inversion may be set up (see p. 480); also serious lacerations of the cervix and perineum may occur in primiparæ, and in consequence there is increased risk of sepsis. Owing to the fact that the patient is taken unawares, delivery may occur in the erect position and the child may be killed by a fall on the floor, if the cord gives way under the strain. Many instances have occurred where it has been

expelled into the water-closet. Of 800 cases of precipitate labour collated by Bayer, it was found that in only 15·5 per cent. was the patient delivered while lying down. The opportunity of treating such cases will seldom arise; uterine action should be retarded as much as possible by the free administration of chloroform.

Uterine Inertia.—Two varieties of uterine inertia are described, *primary* and *secondary;* these are really distinct conditions which have nothing in common, but it is convenient to retain the names by which they are usually known.

(1) *Primary inertia* is a condition in which the uterine contractions are ineffective, the resistances being normal—*i.e.*, the fœtus and pelvis are of normal size, and there is no cause of obstruction. The first and second stages are greatly prolonged, and assistance in delivery is frequently required; the third stage is, however, in all respects normal, therefore the function of retraction is adequate, although that of contraction is not. The contractions may be either feeble or partial, or both feeble and partial; the intervals are usually irregular and prolonged. Sometimes the patient complains of almost continuous severe pain, but on palpation only feeble, and often partial, uterine contractions can be felt, yet these contractions may appear to cause much more severe pain than the effective contractions of a normal labour.

It is met with more commonly in primiparæ than in multiparæ, and is not associated with errors of general health or development. Sometimes a disturbance of the normal mechanism of labour, such as over-distension of the uterus (hydramnios, twins), ante-partum rupture of the membranes, or mal-presentation, appears to induce primary inertia. Frequently, however, no such cause can be discovered, and the condition has then been referred to defective innervation of the uterus, reflex disturbance of the action of the lumbar centre, degeneration of the uterine muscle, &c. Evacuation of the bladder or rectum, when these viscera are full or over-full, often produces a favourable influence, and it is fair to conclude that such conditions may reflexly disturb uterine contractions. Nothing is definitely known of any form of degeneration of the uterine muscle which may

cause primary inertia. Unusual nervousness on the part of the patient is often observed, and may possibly in some way disturb the normal innervation of the process.

The results of primary inertia are, as a rule, not serious either to mother or child. If the mother is allowed to remain in constant pain and without sleep for twenty-four hours or longer, she will become greatly exhausted, and such cases have been known to terminate fatally. As long as the membranes remain intact the fœtus will not suffer.

Treatment.—The management of a labour complicated by primary inertia greatly taxes the strength and patience of the mother, and, it may be added, of the doctor and the nurse also. The general indication must be said to be to postpone operative interference as long as possible ; the temptation to expedite matters by some operative method must be resisted until time has been allowed for the natural forces to advance the course of labour as far as they can. Then comes the moment at which interference is proper and desirable.

During the *prolonged first stage*, what the patient suffers from most is fatigue and want of sleep. Sedatives must therefore be administered. Chloral hydrate, bromides, or morphia, unless administered in large doses, do not exert sufficient influence upon the uterine contractions to allow of sleep ; if they are given in sufficient doses to produce sleep they arrest the progress of labour. The best remedy is a combination of scopolamine (hyoscine) and morphia, in the dose of $\frac{1}{100}$ grain of the former and $\frac{1}{6}$ or $\frac{1}{8}$ grain of the latter, given hypodermically. A great many clinical observations have now been made with this remedy in labour, and its safety and usefulness may be considered as satisfactorily established. It has been administered freely both in normal and in protracted labour. The effect is to make the patient drowsy so that she sleeps almost continuously between the pains, waking up whenever the contractions recur. The pains themselves, so far from being retarded, often gain in strength and regularity, although the intervals between them may be unusually long. If one dose does not produce a marked effect, it may be repeated after an hour to two hours have elapsed. Sleep once induced may be maintained by doses of $\frac{1}{200}$ grain of scopolamine, the morphine being added to every third or fourth dose. It is quite possible by

the use of these drugs to keep the patient in a condition of narcotic 'sleep' throughout the whole course of labour; she is then unconscious of pain throughout, and wakes up to find the child born and the labour ended. In certain Continental clinics this has been practised over a large series of normal and abnormal cases without maternal mishap. Constant medical supervision is, however, requisite, and accordingly it is unsuitable for the conditions which prevail when women are confined in their own homes, as is usually the case in this country. The effect of these narcotics in assisting dilatation of the cervix is very marked, but on account of the long intervals between the pains, progress is slow. If forceps are required, light chloroform anæsthesia must be super-added. In the second stage they must be used with caution, and only when it is clear that progress is very slow and it is desired to postpone instrumental interference, as in cases of pelvic contraction (see p. 416). A distinct but not dangerous soporific influence is often manifest in the child when born, but this seldom reaches a degree in which it interferes with the establishment of the respiratory function. It is, of course, inadmissible to administer hyoscine and morphia to a woman suffering from cardiac or pulmonary disease.

If these remedies fail, some artificial method of aiding dilatation will be required; if the cervix is less than two-thirds dilated the use of de Ribes' bag is probably the best method; if two-thirds dilated or more, and the pelvis is of normal size, dilatation may be completed with the fingers under anæsthesia, and the forceps at once applied. Digital dilatation of the cervix is an operation by no means devoid of risk (see p. 670); it should not be lightly undertaken, and in performing it great care and strict antiseptic precautions are required. When used merely to complete the natural process of dilatation there is not much risk of serious injury.

Many attempts have been made to excite stronger and more efficient contractions by stimulation of the uterus, but these are all unreliable, and need not be described. It should not be forgotten that a distended bladder or a loaded rectum often exert a very unfavourable influence upon uterine contractions, and the condition of these organs must not be overlooked.

The *second stage*, if allowed to proceed without interference, will also be very protracted. But it is not necessary to await the expulsion of the child by the natural efforts, if the presentation is a vertex and no cause of obstruction exists ; labour may then be terminated by forceps as soon as dilatation of the cervix is complete. With a breech presentation delay may be desirable in the interests of the child.

(2) *Secondary inertia* is in reality *exhaustion* of the uterus ; it is marked by a complete cessation of uterine action, bringing the process of labour to a standstill ; the functions of contraction and retraction are both in abeyance ; in this important respect it differs essentially from primary inertia. The labour usually commences normally with satisfactory or even unusually vigorous pains, but they soon die away, either rapidly or gradually ; in other words, the uterus is capable of acting normally at first, but cannot maintain its action for a sufficient time to terminate labour. It may occur at any stage of labour—rarely in the first, more frequently in the second and third ; it may also supervene suddenly when labour is entirely over, resulting in the complete loss of the power of *retraction*. It occurs mainly in multiparæ, and is found especially in those who have had a rapid succession of pregnancies ; there is no doubt that it depends upon some defect, either in structure or in innervation, of the uterine muscle ; the nature of this defect is, however, unknown. No harm, either to mother or child, follows its occurrence during the second stage, for the head may remain for many hours in the pelvis, when both are of normal size, without injurious effects. After a more or less prolonged interval the pains usually return and labour terminates naturally. When inertia occurs after the expulsion of the child, serious hæmorrhage results, owing to the fact that the exhausted uterus is unable to retract.

The *treatment* during the first or second stage is to procure sleep by the administration of morphia or chloral. After a period of sleep, uterine pains will probably recur spontaneously, and labour should then be terminated as rapidly as possible, or the uterus will again become exhausted. The temptation to deliver with forceps in the total absence of uterine contractions must always be resisted. It is a cardinal

rule of obstetrics that delivery should never be effected by artificial means in secondary inertia, for the most serious and uncontrollable post-partum hæmorrhage may result from a breach of this rule. The treatment of secondary inertia in the third stage and after labour is considered on p. 518.

Minor degrees of secondary inertia may be successfully treated by drugs during the second stage. The most useful are pituitary extract, the effect of which in stimulating the uterine muscle has been already alluded to, and ergot.

Pituitary Extract.—Extended experience of this remedy has shown it to be of great value in obstetrics. It is undoubtedly the most potent drug we possess for stimulating the activity of the uterine muscle. It has comparatively little effect on the *inactive* uterus, but upon the parturient uterus its effects are very marked. Its action is temporary only, and lasts on an average from one to two hours. It is very important to use a reliable preparation, such as that sold under the name of "pituitrin."

It should not, as a rule, be given during the first stage of labour, for the reasons: (*a*) that a rigid cervix may be ruptured by sudden powerful contraction of the uterus; (*b*) that there is some risk of fœtal asphyxia from interference with the placental circulation; this action is more dangerous in the first than in the second stage, when delivery can be at once effected if the signs of fœtal distress are observed. During the second stage, whenever causes of obstruction can be excluded, pituitrin is of great value; if the uterus is acting well its use is unnecessary; but in cases of inertia, complete or partial, its effect is well seen, and by its use a forceps operation may be frequently avoided. In a multipara the effect of a single dose is often to effect delivery within a quarter of an hour.

In the third stage or after labour it may be given as an alternative to ergot for the purpose of ensuring complete uterine retraction.

The dose is 1 c.c. of "pituitrin," or 1 c.c. of a 20 per cent. solution of pituitary extract; the injection should be made deeply into the muscles of the buttock or thigh. A second dose may be given in an hour if the effect of the first is inadequate.

Ergot may also be made use of in similar circumstances,

but its effect is less certain and less decided than that of pituitary extract.

The Action and Uses of Ergot.—In small doses ergot acts as a general hæmostatic, contracting the calibre of the peripheral blood-vessels ; this action is made use of in cases of slight bleeding from the uterus during pregnancy. In larger doses it exerts a specific effect upon the uterine muscle when in action. This effect is to increase the force, duration, and frequency of the uterine contractions and to stimulate retraction. In still larger doses the effect is intensified and the whole uterine muscle passes into a condition of tetanic contraction. Ergot is unable, in any dose, to transform the contractions characteristic of pregnancy into those characteristic of labour ; therefore it is useless for inducing abortion or premature labour, and its specific effect is manifested only upon the parturient uterus. It is believed that ergot acts upon muscle by stimulating the peripheral nerve terminations.

It is found, clinically, that the action of ergot upon the parturient uterus is somewhat variable and uncertain, and this appears to be due to the difficulty of making efficient pharmaceutical preparations of the drug. Accordingly the effect is difficult to control, and there is some risk of producing tetanic contraction by its use except in small quantity. It is, as a rule, withheld until after the expulsion of the afterbirth for fear of inducing tetanic contraction in the third stage (see p. 517) ; it may, however, be administered towards the end of the second stage to stimulate the uterus and as a preventive of third stage or post-partum inertia under certain well-defined conditions as follows : if the presentation is a vertex, the patient a multipara, and no condition likely to cause obstruction to, or delay in, delivery is present. Under these conditions it may be given in secondary inertia, or after prolonged chloroform anæsthesia. After the termination of the third stage, it is useful in multiparæ, in maintaining uterine contraction and promoting the expulsion of blood-clot from the uterus. Primiparæ do not, as a rule, require it after labour, and it should seldom be given to them during the second stage, lest serious laceration of the pelvic floor should occur from too hasty expulsion of the child.

Over-action of the Uterine Muscle.—This condition is the opposite of inertia ; both the functions of contraction and retraction are, or may be, exaggerated as the result of excessive stimulation. Three varieties of this condition are to be described :—

(1) Excessive uterine retraction, leading to over-distension of the lower uterine segment and formation of an exaggerated *retraction ring.*

(2) General tonic contraction of the uterus.

(3) Local tonic contraction of the uterus leading to a *contraction ring.*

(1) *Excessive retraction* may be considered first as being the simplest of the three varieties. It results from mechanical obstruction to delivery, in consequence of which the upper active part of the uterus makes violent efforts to overcome the obstacle. Retraction of the upper part gradually attains an extreme degree, while the lower passive part simultaneously becomes attenuated. Consequently the level of the transition from active to passive parts is marked by an abrupt change in thickness of the wall, forming an unusually well-marked " retraction ring." It is therefore an exaggeration of the normal action of the parturient uterus, and is seen in cases of obstructed labour, representing an attempt to overcome some serious mechanical obstacle to delivery. It will be further referred to in a later section.

(2) *General Tonic Contraction.*—This condition, on the other hand, represents, not an exaggeration of normal function, but a perversion of function of the uterus. The physiological differentiation of the uterine body into an upper active and a lower passive portion (lower uterine segment) is lost, and pronounced retraction occurs in the whole of the uterus, with the exception of the part below the internal os. In an extreme case intermittent contractions cease, and the whole organ passes into a condition of tonic muscular spasm or tetanus.

It results from irritation or over-excitation of the uterus during labour, and only very powerful stimuli, in operation for a long time, can cause it. Thus it may occur during labour from three main causes : (1) from the unsuccessful efforts of a powerfully contracting uterus to overcome obstruction ; (2) from the irritation caused by repeated

unsuccessful attempts at artificial delivery ; (3) from injudicious administration of ergot. In the worst instances, the two first-named causes are both present. It involves the most serious risks to the mother and child.

Complete tonic contraction is characterised *clinically* by severe and continuous pain, leading after a time to rise of temperature and quickening of pulse. The liquor amnii is completely expelled, the placenta becomes compressed against the body of the fœtus, and the latter will consequently in a short time perish from asphyxia. Intermittent contractions have ceased, and on abdominal examination the uterus will be found to be small, tender to the touch and continuously hard, so as entirely to obscure the outlines of the fœtus on palpation. As the fœtus is dead, the heart-sounds have ceased. On vaginal examination the presenting part will be found immovable and covered with a very large caput succedaneum ; if the condition has persisted for some time the vaginal and vulval mucous membranes will be found swollen, dry, and tender. Cases so severe as this are seldom met with except where repeated unsuccessful attempts at delivery by version or forceps have been made, the irritation caused by the repeated introduction of the hand or the instrument into the uterus being the direct cause of the tetanus. If unrelieved, rupture of the uterus may occur.

The *diagnosis* of general tonic contraction presents no difficulty ; it is impossible, with ordinary care, to mistake it for secondary inertia, a condition in which pains are absent and the uterus is relaxed.

The *treatment* of both forms of tonic contraction is the same (*vide infra*).

(3) *Local Tonic Contraction.*—In this condition an annular area of the uterine wall passes into tonic contraction, while the parts above and below it continue to play their normal physiological part. In other words, the upper part contracts intermittently, while the lower part is relaxed. The consequence is that a narrowing of the lumen of the uterus occurs at the affected part, the constriction being of a dense and highly resistant character (Fig. 239). This annular constriction may be termed the *contraction ring*, to distinguish it from the *retraction ring* already described in connection with the physiology of normal labour. The contraction

ring is always situated in the lower part of the body of the uterus, and apparently above the level of the internal os. It is largely owing to the recent work of British obstetricians that this form of tonic contraction has been recognised and

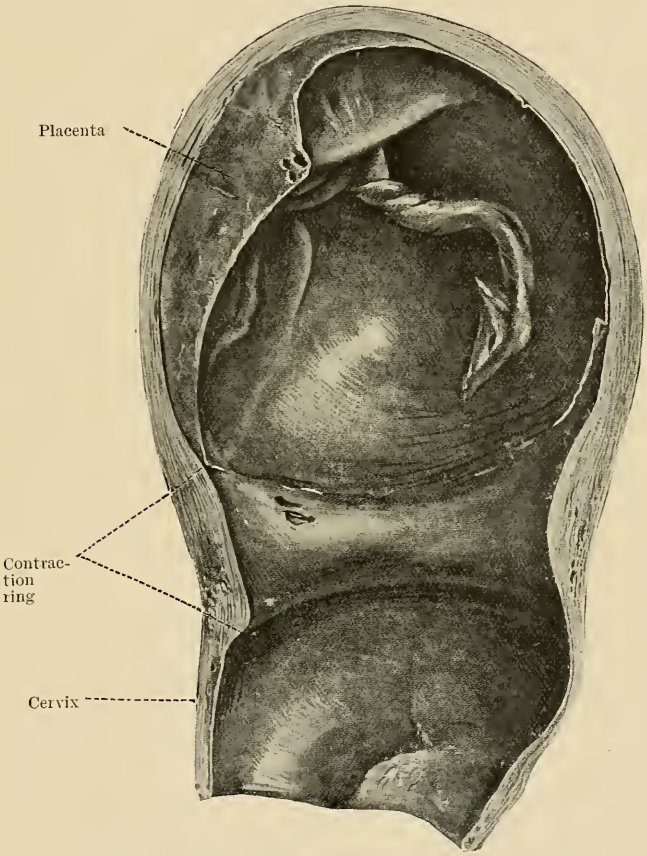


Fig. 239.—Local Tonic Contraction of the Uterus. (Clifford White.)

understood. The causation of this variety is similar to that of general tonic contraction, but may be regarded as the response to a less powerful irritation Cases have been recorded in premature rupture of the membranes in which no obstetric interference had been practised; after intra-uterine manipulation; after mal-presentation, uncorrected

for a long time ; and after uterine infection during labour. In the great majority of cases the ring has been observed during the second stage of labour ; in some instances during the third stage, when it obstructs delivery of the placenta : one case has been observed in which it formed during the first stage, the membranes being intact. When occurring in the third stage it gives rise to the condition known as ' hour-glass contraction ' (p. 513).

The effect of the contraction ring is completely to obstruct the further advance of the fœtus. As a rule the ring is found to be firmly moulded upon some relatively small part of the fœtal body, such as the neck in head presentation, or a limb in shoulder and breech presentations. In a few cases it has formed altogether below the presenting part, the entrance of which into the brim has thus been effectually prevented. In either case labour is brought to a standstill, and further progress is impossible until the condition has been relieved.

The diagnosis of the *contraction ring* is made by finding the constriction on vaginal examination. The general condition of the patient, as a rule, remains good, temperature and pulse being normal ; in this respect the distinction from general tonic contraction is well marked. On abdominal examination the greater part of the uterus still shows intermittent contraction, and during the intervals of relaxation the position and parts of the fœtus can be made out. The presence of the ring is not recognisable, as a rule, on abdominal examination. On vaginal examination the condition will escape notice unless the fingers are passed well up above the presenting part, except in the rare instances in which the ring forms below it. Examination under anæsthesia to discover the cause of the delay in labour will permit of palpation being effectually carried out. Care must be exercised in attempting to pass the fingers through the ring, as rupture of the uterine wall may easily be caused.

The *treatment* of both varieties of tonic contraction may now be considered.

(*a*) *General Tonic Contraction.*—This condition offers the greatest difficulty to delivery by the natural passages. The child is invariably dead, and treatment can therefore be regulated entirely by the maternal interests. Owing to

the non-differentiation of the uterus into active and passive portions, the muscular spasm tends not to expel the fœtus, but to hold it tightly in position. This effect has been aptly designated by Eardley Holland "active retention of the fœtus." This force, which is very powerful, must be overcome before the child can be extracted.

Many attempts to cause relaxation of the muscular spasm have been made, but with constant ill-success. Full doses of morphia aided by chloroform anæsthesia fail as a rule, and owing to the serious constitutional symptoms which are present a long delay is contra-indicated. Operative measures must, therefore, be adopted in almost all cases. The most suitable method is embryotomy, but the conditions do not always permit of this being effectually carried out. If the head presents it should be perforated and crushed by the cephalotribe; traction should then be applied to the instrument carefully and continuously, without the exercise of undue force. While traction is being applied delivery of the trunk may be assisted by division of the clavicles (cleidotomy) to diminish the width of the shoulders. In presentation of the breech or shoulder embryotomy may be very difficult to carry out, and Cæsarean section is the only alternative, followed by removal of the uterus if signs of uterine infection are also present.

(*b*) *The Contraction Ring* is to be treated upon the same general principles. The general condition of the mother being usually good there is not the same urgency, and more time may be expended in efforts to deliver. Narcotics, even when combined with anæsthesia, have little effect upon the spasm. The child is in almost all cases dead, and there is, therefore, no objection to embryotomy; owing to the localisation of the obstructing ring, this operation is also easier to carry out. When the child is dead and the head presents, craniotomy should be performed before attempting extraction, for even in skilled hands forceps delivery may result in serious rupture of the uterus.

Ante-partum Rupture of the Membranes.—When intra-uterine tension is considerably increased during the latter weeks of pregnancy, as in twins or hydramnios, or when from unusual opening up of the cervix before labour the lower pole of the ovum is unsupported, or when from any

cause the chorion and amnion are unusually weak, rupture of the bag of waters may occur before labour has begun. This is known as ante-partum or premature rupture of the membranes. It is met with chiefly in connection with hydramnios or multiple pregnancy, conditions which frequently occur together. The immediate result is the escape of liquor amnii ; this usually occurs slowly, but large quantities may be gradually discharged, the flow being usually intermittent, and corresponding with the involuntary uterine contractions. Ultimately labour supervenes ; but several days may elapse before this occurs, and even intervals of several weeks are not very uncommon. If the fluid is in considerable excess, no harm will follow from the escape for several days, for sufficient will remain in the uterus to protect the fœtus from injurious pressure.

With regard to *diagnosis* one point only requires mention —viz., that after ante-partum rupture of the membranes and escape of a good deal of fluid the examining finger may still detect the presence of a small lax bag of waters below the presenting part. This may be explained by the fact that in such cases the point of rupture is not the lower pole of the membranes, but some point higher up, the fluid escaping from the amniotic sac and finding its way between the chorion and the uterine wall into the vagina. Again, in rare cases, small quantities of fluid may be present between the chorion and the amnion, which may escape by rupture of the chorion, the amnion remaining intact. In this case also a bag of waters will be found, but the quantity of fluid lost in this way is always small.

The course of *labour* is usually unfavourably influenced both as regards the mother and the child. Owing to the absence of the natural cervical dilator—the bag of waters—the first stage is prolonged and made difficult. But if a fair-sized bag should remain, this difficulty will be in great part obviated. From the co-incident over-distension of the uterus primary inertia is frequently met with. Infection of the amniotic cavity by pathogenic organisms, from a morbid vaginal secretion, or introduced from without by examination, may occur. In some such cases the liquor amnii becomes offensive, but this is not invariably the case ; fever and other signs of sepsis may form the earliest indication that

intra-uterine infection has occurred. The fœtus invariably perishes under such circumstances, either during or soon after labour. Further dangers to the child are that the cord or a limb may prolapse, or that the uterus may close down upon it when all the liquor amnii has escaped, and by compression of the placenta lead to death from asphyxia.

Management.—When rupture of the membranes occurs before labour, interference is not immediately indicated, for there is no danger to the child until the whole of the liquor amnii has drained away. In many cases labour will ensue spontaneously within a day or two, although much longer intervals often elapse. The patient should be kept in bed, or at least lying down, and careful examination should be made daily to determine (1) the amount of liquor amnii which remains in the uterus ; (2) the condition of the fœtal heart-sounds ; (3) the absence of signs of infection. The degree of mobility of the fœtus and the girth of the abdomen are the best guides to the amount of fluid present ; while the heart-rate remains between 120 and 140 no harm from compression need be feared, but a steady or continuous rise or fall of the rate, above or below this level, forms an important danger-signal.

It is best to induce labour in two or three days, even if there are no signs of fœtal distress ; but this should be done at once if evidence either of fœtal compression or of uterine infection is obtained earlier than this. The best method to employ is the introduction of the de Ribes bag ; this instrument not only dilates the cervix and excites uterine pains, but also prevents further escape of liquor amnii by plugging the lower segment and cervix. The cervix is usually sufficiently dilated to admit the dilator in these cases, but if not it must be previously stretched to the required size (see p. 663).

Obstructed Labour

This term may be conveniently applied to *cases in which spontaneous delivery through the natural passages is impossible.* A considerable number of different conditions, which may be tabulated as follows, may cause obstruction in labour, although all of them do not invariably produce that result :

I. *Maternal Conditions.*
- Pelvic contraction.
- Tumours of the pelvic bones.
- Ovarian and uterine tumours.
- Undilatable atresia of the cervix or vagina.

II. *Fœtal Conditions.*
- Brow presentation.
- Face presentation with backward rotation of the chin.
- Transverse presentation.
- Locked twins.
- Certain developmental anomalies :
  - (*a*) Hydrocephalus.
  - (*b*) Gigantism or post-maturity.
  - (*c*) Abdominal tumours or ascites.
  - (*e*) Spina bifida.
  - (*f*) Double monsters.

The maternal conditions and the mal-presentations named in this list have been already considered. The remaining fœtal conditions may be briefly referred to before considering the clinical results of obstructed labour. It will be observed that while in hydrocephalus the difficulty will be to deliver the *head*, in the conditions named after it, the difficulty will be in delivering the *trunk*.

Hydrocephalus.—This condition consists in an enlargement of the head due to an accumulation of fluid ; in the great majority of cases this accumulation occurs in the cerebral ventricles (hydrocephalus internus), in others it occurs in the sub-arachnoid space (hydrocephalus externus). The amount of fluid present, and the consequent enlargement of the head, ranges widely in different cases. A case has been recorded by Anton in which the cubic capacity of the skull was found to be 8,300 cc. ($14\frac{3}{4}$ pints) ; amounts of from two to three pints have frequently been withdrawn from the head after puncture or perforation during labour. It is obvious that a degree of obstruction sufficient to cause serious difficulty in labour would result from the presence of a much smaller amount of fluid than this, and as a hydrocephalus of moderate size is more difficult to recognise before birth, such cases often give rise to more trouble than those of the largest size.

The hydrocephalic head is globular in shape, the brow protuberant, the face of relatively very small size; the cranial bones are poorly ossified, as a rule, thin and sometimes crepitant on pressure; the sutures and fontanelles very wide. Occasionally a hydrocephalic head is found fully ossified. Other deformities are not uncommonly associated, such as spina bifida, meningocele or encephalocele, club foot, etc. The amount of brain substance present varies with the degree of fluid accumulation; in bad cases it exists only in the form of a thin shell enclosing the fluid, and there is no distinction to be perceived between the grey and the white matter. The cerebellum and the cranial nerves are often unaffected. Minor degrees of hydrocephalus are not incompatible with the development of a normal or even of an unusually high intelligence.

The *cause* of hydrocephalus is unknown. Hereditary syphilis is regarded as a predisposing factor, and there is no doubt that hydrocephalus occurs with uncommon frequency among syphilitic fœtuses. The occasional occurrence of a series of cases in the same family has been observed, and if in such instances syphilis has been excluded, it suggests that heredity may be an important causal factor. Many authorities believe that pre-natal meningitis is the actual precursor of the excessive formation of fluid, the ependyma of the lateral ventricles being the parts chiefly affected; such changes can be frequently demonstrated after birth. Meningitis may be the result of a syphilitic paternal taint.

During *pregnancy* hydrocephalus gives rise to no complications, as a rule, and is accordingly seldom recognised. During labour it may give rise to obstruction of the most serious kind resulting in rupture of the uterus. In 109 cases of labour with hydrocephalus recently collated (Hohl, Schuchard and Veit), twenty deaths occurred from uterine rupture. The difficulty of diagnosis during labour accounts for this heavy maternal mortality. Breech presentation is more common than in normal cases, but the majority present by the head. Owing to the soft consistence of the markedly hydrocephalic head the condition is by no means easy to recognise on abdominal examination, especially if the breech presents. Vaginal examination, with the head presenting

may reveal very wide sutures and fontanelles, with thin crepitant bones, but the latter sign occurring alone has no diagnostic significance as it may be met with when the head is of normal size. Owing to the fact that the head is too large to enter the brim of the pelvis, palpation of the sutures is practically impossible early in labour, and the diagnosis can only be made by a careful bi-manual examination under anæsthesia. When the cervix dilates, and partial moulding of the head occurs, the presenting part comes down within reach. If, however, the risk of rupture of the uterus is to be avoided early diagnosis is necessary. Accordingly, in all cases, the sign upon which reliance must be placed is

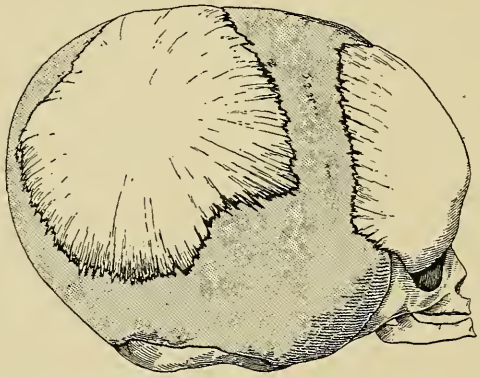


Fig. 240.—The Skull in Hydrocephalus.
(Ribemont-Dessaignes and Lepage.)

the recognition by bi-manual examination of the cephalic enlargement ; anæsthesia is required for this during labour, and the bladder must, of course, be empty.

The maternal risk is greatest when the head presents, for if the condition is not recognised, over-distension of the lower uterine segment leading to rupture is very likely to occur. With the after-coming head there is less risk, as the uterine contractions are then too feeble to over-distend the lower uterine segment.

The *management* of a case of hydrocephalus is a matter of some anxiety. Spontaneous delivery is not to be anticipated, even in cases of moderate size, except where the fœtus is macerated. Some method of reducing the size of the head

is practically always indicated. The chances of survival of a hydrocephalic child are so precarious that we are not justified in incurring the least unnecessary maternal risk in delivery. Consequently when the head presents, the diagnosis having been confirmed by bi-manual examination under anæsthesia, the head should be perforated through a suture or a fontanelle. This procedure is simple and easy. If, however, labour has been in progress for some hours and the signs of distension of the lower uterine segment are recognised (see p. 463), the extraction of the child requires great care. Often the head can be extracted by direct traction exerted by a finger passed into the skull through the perforation aperture and aided by pressure from above on the fundus (Birnbaun). This is preferable to the use of the cranioclast or cephalotribe for traction, as owing to the softness of the cranial structures a good hold cannot be obtained and the blades are therefore liable to slip. After reducing the size of the head version may be performed, but this should not be attempted until after perforation; the after-coming head can then be extracted with comparative ease. When the child presents by the breech the condition of the head is usually unrecognised until the trunk has been born. Perforation through the tubular occipital bone or through the hard palate is easy as a rule. If owing to the presence of pelvic contraction the head is too high to be easily reached with the perforator, it is safer to divide the vertebral column in the upper dorsal region, and pass a catheter up the vertebral canal into the skull, when sufficient fluid may be withdrawn to allow of the delivery of the head by gentle traction.

Gigantism and in some cases enlargement of the trunk from *general fœtal œdema* may lead to great difficulty in delivering the trunk. In head presentations the greatest obstacle to be overcome is the breadth of the shoulders (bis-acromial diameter). This prevents trunk rotation, and thus adds to the difficulty. The bis-acromial diameter can, however, be effectually reduced by division of the clavicles (see p. 749), and as the child is in all such cases dead, there is no objection to this procedure. The trunk can then be delivered by steady traction applied to the axillæ, aided by pressure from above. When the breech

presents in such cases, the arms invariably become extended and the difficulty of delivery is also very great. Destructive operations are inevitable, and evisceration of the thorax and abdomen is the best procedure; it will then be possible to reach the arms to deliver them in the usual manner. It may, however, also be necessary to perforate the after-coming head, and in order to minimise the risks of injury to the maternal passages, this should be done in preference to a difficult extraction by some other method.

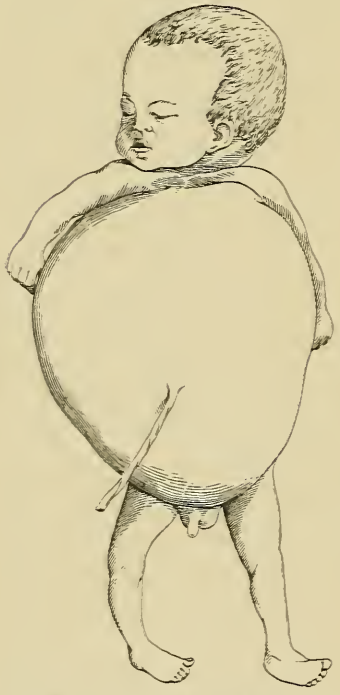


Fig. 241.—Fœtal Ascites. (Ribemont-Dessaignes and Lepage.)

Fœtal Abdominal Enlargement.—The commonest cause of congenital enlargement of the abdomen is *ascites* (Fig. 241); rarer causes are over-distension of the *bladder* from urethral stenosis, *cystic tumours* of the *kidney* or the *ovary*, and *syphilitic disease* of the *liver*. An enlarged abdomen may cause insuperable obstruction to the delivery of the trunk; the presenting part—head or breech—is small, and the condition will therefore as a rule be overlooked, until the process of expulsion becomes arrested. Diagnosis can be established by passing the fingers into the vagina under anæsthesia, and carefully estimating the size and outline of the retained trunk. The treatment is, in the case of fluid swellings, to tap the abdomen, and under all other conditions to eviscerate.

Double Monsters.—These are twin fœtuses developed from a single ovum, and organically united by their trunks; some vital organ, such as the liver, the heart, or one of the great arteries, is always common to the two. The differential diagnosis from locked twins may be very difficult during

labour. Being usually small, they do not cause such serious obstruction as would be supposed, and spontaneous delivery may sometimes occur. Decapitation or evisceration may be necessary if the fœtuses are of average size.

Clinical Results of Obstruction.—All of the conditions mentioned above do not invariably give rise to an obstructed labour. The course of labour is greatly influenced by two other factors in addition to the presence of some cause of obstruction: these are (*a*) the size of the fœtus, (*b*) the strength of the uterine contractions. Thus, many of the fœtal conditions just enumerated will not cause insuperable obstruction if the fœtus is of small size: *e.g.*, transverse presentation and locked twins. And, further, a degree of obstruction which would be insuperable to a feeble uterus may be overcome when the uterus contracts powerfully. The influence of the uterine contractions is especially important in the case of vertex presentations in a contracted pelvis, for the moulding of the head necessary for its passage through the pelvis will not occur unless the uterus acts powerfully. Accordingly a multipara with slight pelvic contraction who has been delivered either spontaneously or with the aid of forceps in her early labours, may suffer from insuperable obstruction in the later ones, owing to the enfeeblement of the uterus.

The results of obstruction to labour are extremely serious, unless the condition is recognised and appropriately treated early in labour. If exhaustion of the uterus (secondary inertia) occurs, danger is postponed, at any rate for a time. Sometimes tonic contraction will come on, and may lead to the death of the undelivered patient from exhaustion. More frequently obstruction leads to over-distension of the lower uterine segment, and rupture of the uterus or of the uterus and vagina.

Exhaustion from obstructed labour is characterised by local signs of tonic uterine contraction, rise of temperature, rapidity of pulse and respiration, dry tongue, œdema and arrest of secretion of the walls of the vagina and vulva, and finally delirium or convulsions terminating in death. The signs of *over-distension* of the lower uterine segment will be described in connection with the mechanism of uterine rupture.

Diagnosis.—Most of the conditions liable to cause serious obstruction in labour are capable of recognition by careful and systematic examination during the latter weeks of pregnancy. Exceptions to this statement are brow presentations, locked twins, and fœtal abdominal enlargements ; the maternal causes are all discoverable before labour. When an ante-partum diagnosis has been made, suitable measures may be adopted in advance for the safe delivery of the patient, and the importance of prophylaxis in these cases cannot be over-estimated. When the diagnosis is not made until labour has begun, the conditions are of course less favourable, and the longer labour has been in progress before the obstruction is discovered the graver is the prognosis.

There are certain conditions in labour which should at once arouse the suspicion of some cause of obstruction ; thus if the mother shows obvious bony deformity or is stunted in stature ; if the presentation cannot be made out owing to the presenting part being unusually high ; if notwithstanding good uterine pains the presenting part does not come down after the membranes have ruptured ; if the vaginal walls become swollen from œdema, or the presenting parts obscured by a large caput ; if a swelling is found in the pelvis below the presenting part. In each of these conditions serious obstruction may be present. Careful examination under anæsthesia, including an accurate measurement of the diagonal conjugate, must be made in all such cases.

Rupture of the Uterus

Rupture of the uterus is the most serious accident which can occur in labour. It may take place under varying conditions, and two distinct varieties must be recognised—viz., *traumatic* rupture and *spontaneous* rupture. *Traumatic rupture* is met with in very rare instances in *pregnancy* from direct violence, such as a fall, or a blow or kick upon the abdomen ; more commonly it occurs during *labour*, and is due to intra-uterine manipulations such as version, artificial dilatation of the cervix, destructive operations (fœtal), or forceps extraction, performed either unskilfully or under unfavourable conditions. *Spontaneous rupture* is almost

unknown except during labour, and may be due to three different conditions. (*a*) It may be due to over-distension of the lower uterine segment from insuperable obstruction. (*b*) It may be due to uterine defects such as malpositions (*e.g.* pendulous belly and anteversion from ventro-fixation), weakening of the uterine wall by cicatrices of previous Cæsarean section, congenital malformations such as bicornute uterus, &c. (*c*) In very rare instances it occurs during normal labour, or sometimes even during pregnancy, with an apparently healthy uterus; the explanation of the accident under these circumstances is obscure, but isolated cases have been reported in which cloudy or fatty degeneration of the uterine muscle has been subsequently demonstrated.

Multiparity must be recognised as a powerful predisposing cause of both varieties, for in 94 per cent. of cases the victims of this accident are multiparæ. This is explained partly by the weakening of the uterine wall which results from frequent childbearing, and partly from the increased frequency of such causes of obstruction as mal-presentations. The frequency of occurrence of rupture of the uterus is estimated at about 1 in 3,000 labours.

Mechanism of Rupture.—(1) Over-distension of the lower *uterine segment.*—This is the essential cause of spontaneous rupture in all cases due to obstruction. It has been already explained that in normal labour the uterine wall becomes differentiated into an upper active part which retracts as labour proceeds, and a lower passive part which becomes dilated and stretched; separating the two is a well-defined ridge, called the retraction ring, or the ring of Bandl (see p. 274). Sometimes in normal labour this ring can be palpated by abdominal examination in the form of a shallow groove above the level of the pubes. In an obstructed labour—*e.g.* an uncorrected transverse presentation—these changes in the uterus become greatly exaggerated; retraction proceeds to an extreme degree in the active portion, while distension becomes correspondingly extreme in the passive portion, for the reason that the latter is now made to accommodate the greater part of the body of the fœtus (Figs. 201 and 242). In consequence, the ring of Bandl rises up to, or even above, the level of the umbilicus, and

usually runs obliquely across the uterus. The wall of the distended lower segment is greatly thinned, especially in

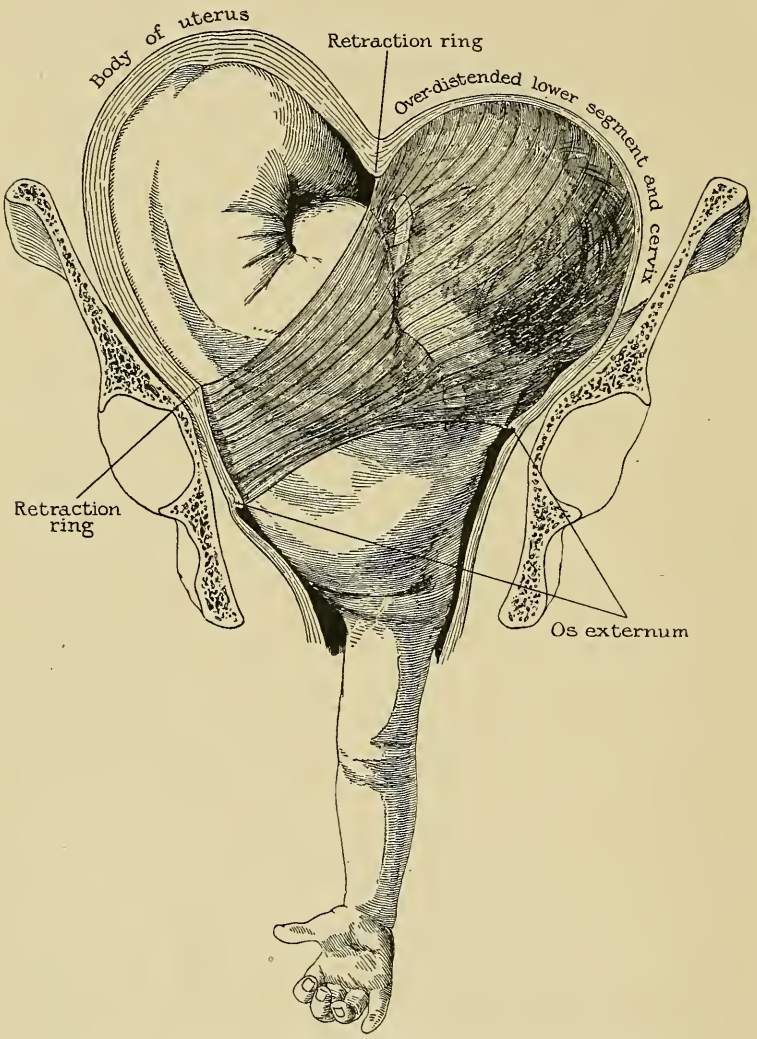


Fig. 242.—Over-Distension of the Lower Uterine Segment in Transverse Presentation. (Bumm.)

the position occupied by the head, and tightly stretched over the body of the fœtus ; it is in imminent danger of giving way before the continuous pressure of the active part of the

uterus, which is in a state of tonic contraction. Accordingly, rupture produced in this manner always begins in the lower segment, but may extend upwards into the body, or downwards into the cervix and vagina.

Over-distension of the lower segment may be clinically recognised in the following manner : On examination of the abdomen the uterus will be found to be hard and tender ; the outlines of the fœtus will be obscure and its mobility limited ; the fœtal heart probably inaudible ; the ring of Bandl will be recognisable as an oblique groove at about the level of the umbilicus ; and one or both round ligaments, tightly stretched over the distended lower segment, may also be felt crossing obliquely the front of the uterus in a direction downwards and outwards towards the middle of Poupart's ligament. It will be remembered that the round ligaments become considerably hypertrophied during pregnancy. On vaginal examination the conditions found will closely resemble those characteristic of tonic contraction. From the latter condition over-distension of the lower segment can best be distinguished by the position of the retraction ring.

(2) *Intra-uterine Manipulations.*—Such procedures as those named above may, from want of skill or care, cause rupture of the uterus when there is no abnormality in labour ; they are, however, much more likely to cause this accident when carried out under unsuitable conditions, such as complete escape of liquor amnii, tonic contraction, or over-distension of the lower uterine segment. Under these circumstances the introduction into the uterus of the hand, or even of a small instrument such as a decapitation hook, is very likely to cause the uterine wall suddenly to give way. Cases of this kind must be regarded as instances of traumatic rupture, for although the condition of the uterus is a powerful predisposing cause, rupture is not spontaneous. Also, methods of rapidly dilating the cervix in labour are always attended by risks of rupture of the cervix and lower segment, for proper regulation of the amount of force employed is very difficult. Again, the extraction of the head by forceps through an imperfectly dilated cervix may cause a deep cervical tear which, if much force is employed, may spread upwards into the lower uterine segment, and according to its situation may lay open either the peritoneal cavity, the broad

ligament, or the bladder. These injuries necessarily involve deep laceration of the vaginal vault as well.

In most cases due to intra-uterine manipulations the rupture starts in the cervix or lower uterine segment ; thence it runs up into the body and usually follows the lateral uterine wall, opening up the broad ligament. The majority of such cases are therefore cases of incomplete rupture. Extensive lacerations may, however, open the peritoneal cavity at once, and numerous cases have been recorded in which a tear has been produced in this way, extending from the fundus above, through the uterine body, lower segment, and cervix, into the lateral vaginal wall. In all such cases, where considerable force has been employed to effect delivery, extensive bruising and laceration are also usually found at the vulva, involving the perineal body and the labia.

(3) *Abnormalities of the Uterus.*—Certain abnormal conditions of the uterus may be the cause of spontaneous rupture or may predispose to traumatic rupture. They may be enumerated as follows :

Cicatrices of previous Cæsarean section.

Fatty or cloudy degeneration of the uterine muscle.

Bicornute uterus (rarely).

Uterine tumours (carcinoma of cervix).

Misdirection of the uterine axis.

Rupture through a Cæsarean section scar is usually longitudinal and situated in the anterior wall near the mid-line (Fig. 243) ; it may, however, be transverse and situated upon the fundus (see p. 727). Conditions 1 and 2 may explain the very rare cases already alluded to in which spontaneous rupture of the uterus occurs in pregnancy or in unobstructed labour. Disease of the uterine muscle can only be recognised by microscopic examination of the organ after its removal from the body. When pregnancy occurs in one horn of a bicornute uterus, the non-gravid horn may be found during labour to occupy a position in which it obstructs the passage of the fœtus through the pelvis, and may then lead to rupture from distension of the lower uterine segment. It is extremely rare for uterine tumours to cause rupture.

Misdirection of the Uterine Axis is the chief cause of rupture in cases of " pendulous belly " (Fig. 59) ; in this condition the axis of the uterus is directed against the pos-

terior wall of the lower uterine segment, and if the displacement is not corrected during labour the presenting part may be driven through the uterine wall at this spot. Extreme lateral obliquity may similarly predispose to rupture. Cases

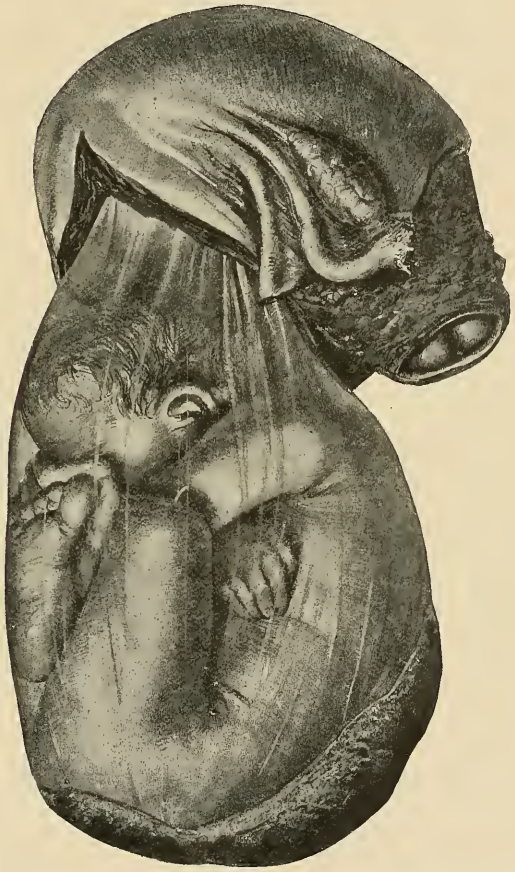


Fig. 243.—Rupture of the Uterus through a Cæsarean Section Scar. (Cameron.)

of spontaneous rupture may be also due to previous operations in which unsuitable methods have been employed for fixing the body of the uterus to the anterior abdominal wall, or the anterior vaginal wall. During pregnancy the development of the attached part of the uterus may then be greatly retarded, the uterus growing, in point of fact, almost entirely

at the expense of its posterior wall, which is consequently very much thinner and weaker than normal at term. There is also marked backward and upward displacement of the cervix, in consequence of which the normal mechanism of parturition is greatly modified.

Morbid Anatomy.—Rupture of the uterus is said to be *complete* when all the coats including the peritoneum are torn, and *incomplete* when this is not the case. Rupture of the lateral wall of the uterus, which in pregnancy is uncovered by peritoneum (see p. 67), may involve the whole thickness of

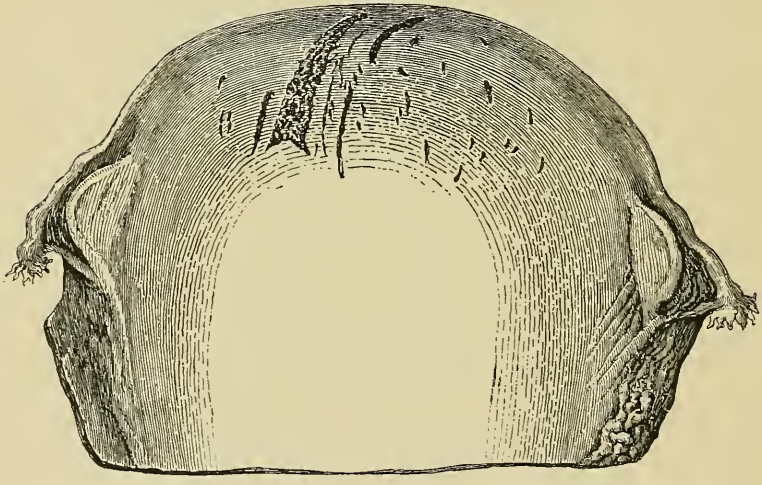


Fig. 244.—Incomplete Uterine Rupture involving the Peritoneal Coat only. (Von Winckel.)

the muscular wall and still be incomplete, as it merely opens up the broad ligament, but does not tear the peritoneum. Further, an incomplete rupture opening up the broad ligament may subsequently become complete by the peritoneal layer yielding, either from the pressure of accumulated blood, from a portion of the body of the fœtus being driven through it by uterine retraction, or from manipulation of the torn parts. Incomplete rupture sometimes involves chiefly the peritoneal coat, occurring in the form of superficial lacerations which gape and may bleed freely (Fig. 244); the causation of this rare accident is obscure.

Cases of spontaneous rupture are more often complete

than incomplete ; cases of traumatic rupture are more often incomplete than complete. In the great majority of cases rupture commences in the lower uterine segment, the reason

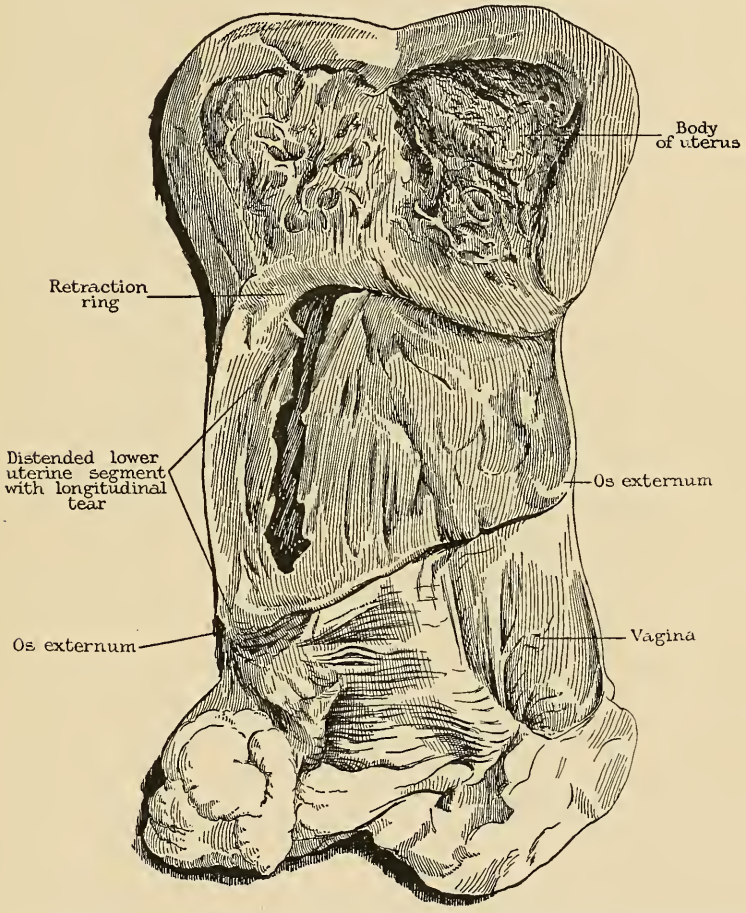


Fig. 245. Rupture of the Uterus limited to the Lower Segment, which is greatly distended; the Distension is greater on one side than the other. (Bumm.)

being that this part of the wall is thinnest and is also most liable to over-distension. The rupture may be confined to the lower segment (Fig. 245), or may extend upwards into the uterine body, even to the fundus, or downwards into the vaginal fornices ; the bladder is occasionally involved in

tears of the anterior wall. In cases due to abnormalities of the uterus, the tear often commences above the lower segment—*e.g.*, the scar of a Cæsarean section may give way. The *direction* of the tear is in the majority of cases oblique ; occasionally it may be transverse, and sometimes a trans-

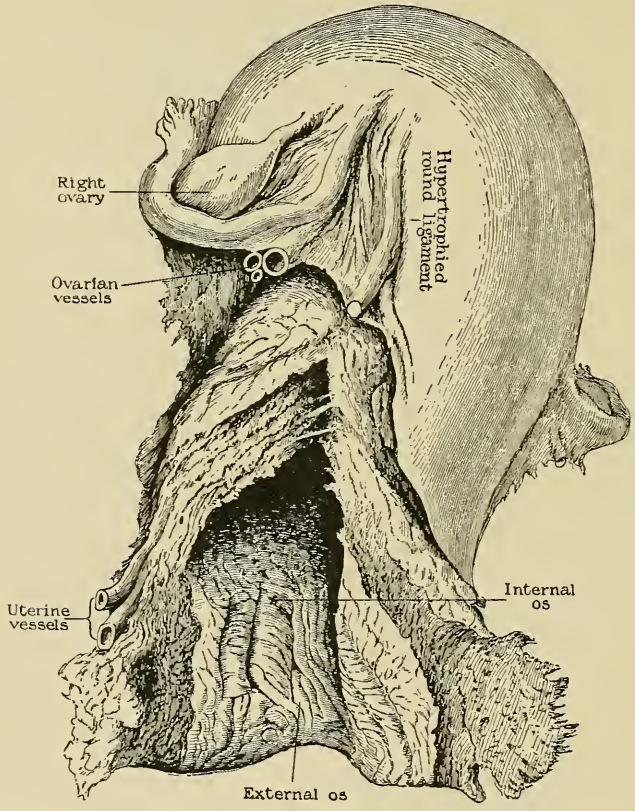


Fig. 246.—Rupture of the Lateral Wall of the Uterus involving Lower Segment and Cervix. (Edgar.)

verse tear encircles nearly the whole lower segment, practically cutting the uterus in two ; occasionally it is vertical, such tears occurring most frequently on the lateral wall of the uterus (Fig. 245). In rare instances transverse rupture starts in, and is limited to, the fundus (Fig. 247). Fundal rupture in most recorded instances has been attributed to abnormal thinning of the placental site ; it may, however,

occur through the cicatrix of a previous Cæsarean section. Sometimes rupture causes laceration of a large branch of the uterine or vaginal artery, or of large uterine veins (Fig. 246); serious hæmorrhage then occurs; this is, however, by no means the rule, and if the large vessels escape, the amount of hæmorrhage may be trifling. Complete rupture of considerable extent involving the peritoneal coat is usually followed by the escape of the uterine contents (fœtus or

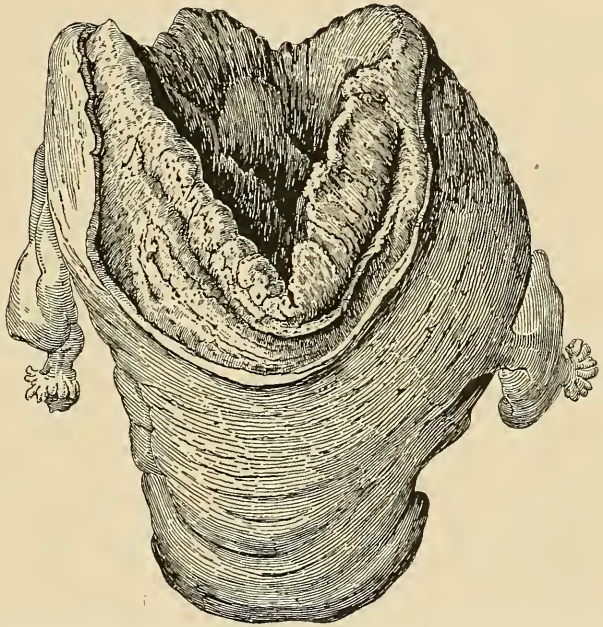


Fig. 247.—Complete Transverse Rupture of the Fundus Uteri. (Von Winckel.)

placenta, or both) into the peritoneal cavity; the empty uterus then retracts firmly and severe hæmorrhage will be impossible, unless large vessels have been torn. When the rupture is small or incomplete the fœtus remains in the uterine cavity. Sometimes a part only of the fœtus—the head or a limb—escapes through the rupture, the remainder being retained in the uterus; firm retraction of the edges of the rent upon the extruded part may then occur, preventing the withdrawal of the fœtus *per vias naturales*.

Diagnosis.—In order to establish the diagnosis of rupture of the uterus, it is usually necessary to recognise the laceration by touch. The symptoms which attend this grave accident are not characteristic, although they may arouse the suspicion that rupture has occurred.

Premonitory symptoms of rupture are sometimes described; these are, in point of fact, a history of a long and difficult labour leading up to the symptoms already mentioned as those of tonic contraction and over-distension of the lower uterine segment (p. 449). But it must be borne in mind that although in the majority of cases a long, difficult, and painful labour precedes rupture, this is not always the case, for spontaneous rupture may occur early in normal labour.

The *attendant symptoms* are probably influenced mainly by the rapidity with which the laceration is produced, and the amount of hæmorrhage which accompanies it. Sudden rupture is attended by severe shock and acute abdominal pain, sometimes also by the sensation that something has burst and by the sudden cessation of the pains, which have been, in most cases, unusually severe. There may be some external bleeding, but this is seldom, if ever, profuse; the greater part of the effused blood is retained when, if a large vessel has been torn, signs of more or less severe internal hæmorrhage gradually manifest themselves. Occasionally internal hæmorrhage may be so profuse as to cause death in an hour or two. Incomplete rupture produces much less severe symptoms, and less profuse hæmorrhage than complete rupture. It may accordingly be said that the chief symptoms pointing to the occurrence of rupture are the sudden or rapid development of symptoms of shock—*e.g.*, pallor, cold clammy skin and rapid pulse, in a case in which labour has been long, or artificial delivery has been accomplished with difficulty. When also there is external bleeding, and though delivery has not taken place the pains suddenly cease, the presumption is greatly strengthened.

Abdominal examination yields no certain information unless the fœtus has escaped from the uterus, when the physical signs are striking. The fœtal parts can be palpated with great ease through the abdominal wall; there is also extreme mobility both of the limbs and of the whole body. In the lower abdomen the hard retracted uterus will be found

of the size natural to the termination of the third stage of labour, and quite separate from the fœtus. If the fœtus remains in the uterus after rupture has occurred, it is seldom possible to make the diagnosis until after delivery.

Whenever it is suspected before delivery that rupture has occurred, a careful examination under anæsthesia should be made, the whole hand being passed into the vagina for this purpose, as it is obviously necessary to reach the lower uterine segment. If the laceration has involved the vaginal vault, the lower end of the tear will be easily found ; the full extent of the injury is often difficult to estimate until the uterus is empty.

In many cases, however, the suspicion of rupture does not arise until after the delivery of the patient, either with or without artificial aid. The bad general condition of the patient then attracts attention, and definite symptoms of severe shock may supervene. If the placenta has escaped through the rent into the peritoneal cavity, attempts to deliver it in the ordinary way will be unsuccessful ; in some cases considerable external bleeding occurs although the placenta has been delivered and the uterus is firmly retracted, or the patient may show immediate signs of collapse ; but in some cases suspicion of rupture has not been aroused for several hours after the termination of labour, owing to the gradual development of the symptoms. Under all such circumstances as these, careful search should be made for rupture. If the placenta has escaped through the rent into the peritoneal cavity, the cord will guide the fingers up to and through the rent. Occasionally a coil of small intestine may protrude through the rupture into the vagina. It is a point of practical importance to decide whether the rupture is complete or incomplete, for treatment depends upon this point to some extent. If a coil of intestine has prolapsed, or if the finger passed through the tear definitely detects bowel or any other organ, such as the omentum or the ovary, it is certain that the rupture is complete. In incomplete rupture opening up the broad ligament extensively, a thin layer of peritoneum and cellular tissue intervenes between the viscera and the finger, and prolapse of gut cannot occur.

Risks.—Rupture of the uterus during labour is one of the most serious accidents which can befall a parturient woman.

The mortality has been estimated by various authorities at from 70 to 80 per cent. ; for cases treated under favourable conditions such as are offered by Lying-in Hospitals it is probably, under modern methods, not more than 50 to 60 per cent. (Munro Kerr). But even this modified rate is extremely high. The *immediate* risks are those associated with shock and hæmorrhage ; if the patient survives these she has still to encounter the more *remote* risks of septic infection. Shock and hæmorrhage occur together, and the influence of the two in determining a fatal result cannot be separately estimated ; deaths occurring within twenty-four hours of delivery are practically all due to these causes. Probably 50 per cent. of the mortality is the result of combined shock and hæmorrhage, the remaining 50 per cent. being due to sepsis. The frequent occurrence of septic infection is to be explained by two considerations. Firstly, rupture of the uterus is as a rule the direct outcome of bad obstetrics, as in the case of failure to recognise a transverse presentation, or of untimely or unskilful operative interference. Consequently it is among the poorest classes that cases of rupture usually occur, and in these patients insanitary surroundings, want of personal cleanliness, and absence of trained nursing attendance all favour the occurrence of sepsis. When a woman suffering from this injury is brought to hospital for treatment she has in many cases been already infected. Secondly, even if skilled attendance in labour has been available, the existence of an extensive internal laceration throwing the vaginal canal into direct communication with the peritoneal cavity or the pelvic cellular tissue, offers unusual facilities for the spread of any infective agent which may gain admission.

Treatment.—This must be considered from two points of view : (1) how to deliver the patient ; (2) how to deal with the rupture.

(1) If it is believed, after careful examination, that the fœtus is still in the uterine cavity, an attempt should be made to deliver it through the natural passages ; causes of obstruction must be carefully looked for and estimated, and suitable methods of extraction then adopted. If the presentation is an impacted shoulder no attempt at version should be made ; but the child may be delivered by decapitation,

or by some method of embryotomy if the neck is difficult to reach (see p. 740). Intra-uterine manipulations under these circumstances are certain greatly to increase the tear if it has already occurred. If a part of the fœtus has escaped through the rent, attempts at delivery through the natural passages must be very gently made. As the fœtus is in all cases dead, destructive operations may be practised without hesitation. If the fœtus has been expelled completely into the peritoneal cavity, laparotomy is the only possible method of delivery which can be adopted. If the child is born but the placenta has escaped from the uterus, the placenta may be drawn down by traction on the cord and delivered with care through the rent.

(2) The *treatment* of the *rupture* is in all cases a matter of difficulty, and great differences of opinion have been expressed as to the best method of dealing with it. Upon one point there is agreement, viz. that the immediate indications are to ascertain the full extent of the injury, and to adopt energetic measures to diminish shock. The entire hand should be passed into the vagina immediately after delivery, so that the position and size of the laceration may be clearly determined. Special attention should be paid to two points—whether the tear has opened the peritoneal cavity or has injured the bladder. The amount of external bleeding is usually slight, but the uterine cavity should be freely irrigated with normal saline solution, and the vaginal walls thoroughly irrigated and swabbed with lysol solution, a teaspoonful to a pint. When the general condition of the patient is grave, and there is severe shock, nothing further should be done until certain restorative measures have been adopted.

The essential feature of shock is profound depression of the circulation, indicated by a small, soft and rapid pulse, coldness and pallor of the skin with slight cyanosis of the lips. The temperature is sub-normal, the respiration shallow but not greatly quickened, the mental condition lethargic ; or there may be loss of consciousness. The reaction is indicated first by improvement in the pulse, and then by a return of warmth to the body surface. When there is severe shock the patient should be kept recumbent with the foot of the bed raised ; if it is desired to move her

into hospital this should be postponed until some degree of reaction has been obtained. The two chief requirements in the treatment of shock are the application of warmth to the body, and the rapid introduction of fluid into the circulation. If hot baths and bottles are used, great care must be taken to keep them from contact with the skin, as severe burns are produced by a comparatively low temperature during shock. In hospital practice the electric light bath is a convenient method of applying heat and may be continued until sweating begins, when its temperature should be gradually reduced. Fluids cannot be administered in large quantity by the mouth, but may be given per rectum, subcutaneously or by intra-venous transfusion. The rectal method is inadequate except for slight cases ; the subcutaneous method will suffice for all but the gravest cases, when intra-venous transfusion must be resorted to. By the latter method success may be attained even when the patient appears to be moribund. Alcohol and strychnine are of little use and by some authorities are held to be harmful. The most useful drug in shock is pituitary extract, which may be given along with the subcutaneous injection of saline in doses of 1 c.c. of a 20 per cent. solution ; its effect is to raise blood pressure.

The treatment of the injury itself may be either expectant or operative. *Expectant* treatment consists in establishing free vaginal drainage from the lacerated parts, combined with plugging of rents or of cavities with gauze, if required for the control of oozing or of more active hæmorrhage. Probably a better method is to drain by means of large rubber tubes which must be stitched in position, and made to pass deeply above the level of the lacerations. Thus the tubes may pass into the peritoneal cavity, or into the widely opened pelvic cellular tissue in cases of incomplete rupture opening up the broad ligament. In all cases where the surroundings of the patient are unfavourable for the performance of a serious surgical operation the expectant method should be adopted. In cases of incomplete rupture it may be possible by making traction on the uterus to pull it down to the vulva sufficiently to allow of the laceration in the uterine wall being directly closed with stitches. The broad ligament cavity then remains in communication with the vagina only; it should not be closed, but plugged with a strip of gauze

or drained with a rubber tube. *Operative* treatment of complete rupture consists in opening the abdomen, and after carefully investigating the position and extent of the injuries, either removing the ruptured uterus altogether by hysterectomy, or sewing up the lacerations. If the patient survives the operation the risk of sepsis has been practically eliminated. When rupture has been followed by escape of the child into the peritoneal cavity an abdominal operation must in all cases be performed in order to deliver the child, and this allows of the rupture being at the same time dealt with.

The advantage of the operative treatment is that the full extent of the injury can be discovered, hæmorrhage completely arrested, bruised or possibly infected tissues or organs removed, the peritoneal cavity cleansed, and free drainage provided both by the supra-pubic and vaginal routes. When the laceration is not very extensive, and is situated in an accessible position, it may be stitched up and the uterus saved. But experience shows that a high mortality from sepsis attends this procedure, for if the uterus is infected the edges of the tear will not unite and septic peritonitis then ensues. The great disadvantage of both forms of abdominal operation is that the patient's general condition is often so bad that the performance of an extensive operation such as these appears to be almost a forlorn hope. On the other hand the expectant method, if at first successful, is attended by grave risks of sepsis in convalescence, for the uterus itself may have been infected during labour, and, further, by this method the peritoneal cavity cannot be thoroughly cleansed. And again, concealed hæmorrhage may continue from some deeply-placed vessel.

The most efficient method is undoubtedly to operate and remove the uterus by hysterectomy; thus bleeding is finally controlled and the risks of sepsis avoided as far as may be. But by many obstetricians the severe shock attending rupture of the uterus is held of itself to contra-indicate such a severe operation as this. Recent statistics, however, appear to show that a larger percentage of recoveries attends hysterectomy than any other method, whether operative or expectant, of dealing with bad cases of rupture of the uterus. It is probable that in time this method will be

generally accepted for such cases, the expectant method being reserved for those in which the injury is comparatively slight.

Lacerations of the cervix and vagina frequently occur in labour and are of minor importance. A certain amount of laceration of the cervix is usual in a primipara and requires no treatment; it is invariably longitudinal in direction and usually lateral in position, being much more frequent upon the left than the right side. This is explained by the predominant frequency of the first vertex position, in which the broad end of the head distends the left side of the cervix. Sometimes these lacerations are more extensive and run up to the vaginal roof, or open the base of the broad ligament; they should then be treated by douching the ragged cavity formed by the tear, and draining it with a large rubber tube. Occasionally transverse rupture of the anterior lip occurs from non-dilatation of the external os, and delivery takes place through the rent which is situated in front of the undilated os (Fig. 237). In extensive rupture of the lower uterine segment the laceration frequently extends downwards so as to involve the cervix and upper part of the vaginal wall.

In severe laceration of the pelvic floor the lower third of the posterior vaginal wall of necessity participates. Vaginal lacerations are thus most frequent in the upper and lower thirds. They may also occur in the middle third in obstructed labour or difficult instrumental delivery; if upon the anterior wall, the base of the bladder may then be lacerated, giving rise to a vesico-vaginal fistula. Sometimes, from prolonged compression between the fœtal head and the pelvic bones, an area of the anterior vaginal wall is damaged beyond recovery, and sloughing occurs. The slough then separates during the first week of the puerperium, and may open the base of the bladder, resulting in a vesico-vaginal fistula. When an extensive area in any position has sloughed, the process of cicatrisation is attended by well-marked constriction, and may result in vaginal atresia of extreme degree. Lacerations of the cervix and vaginal roof do not require suture unless there is considerable hæmorrhage; those of the lower third of the vagina should always be repaired at the same time as the injury to the perineum.

Rupture of Veins (*Vaginal and vulval hæmatoma*).—Large effusions of blood from ruptured veins may form beneath the vaginal walls during labour. The cause of rupture of the vaginal veins is not well known, but the accident occurs chiefly in prolonged labour or operative delivery. It may be also met with in pregnancy as the result of direct injury. The formation of the hæmatoma begins beneath one of the lateral vaginal walls, and usually extends downwards into the labium majus, forming a characteristic vulval swelling which may attain considerable size. Sometimes the tumour does not extend to the vulva, and then it can be recognised only by vaginal examination. The vulval swelling presents distinctive characters; it is soft and fluctuating, of a deep violet colour where covered with mucous membrane, and is associated with subcutaneous ecchymosis, extending over the perineum, around the anus, and upon the inner aspect of the thighs.

A vaginal hæmatoma may form during the second stage of labour, and cause obstruction to delivery; usually, however, it appears during or soon after the third stage. It is associated with severe pain, and the loss of blood from the general circulation may be sufficient to produce urgent symptoms of internal hæmorrhage. Occasionally spontaneous rupture of the hæmatoma occurs, leading to the escape of a large quantity of fluid and clotted blood.

The *treatment* is expectant, with strict antiseptic management of the puerperium. If the thrombus should become infected, it must be laid freely open, the cavity cleared out, douched, and packed with iodoform gauze.

Pelvic Hæmatoma.—The occurrence of hæmorrhage between the layers of the broad ligament in incomplete rupture of the uterus has been already referred to; this condition is called a pelvic hæmatoma. Rare cases have been reported in which the same condition has occurred without injury to the uterus, the source of the bleeding being ruptured veins in the connective tissue of the base of the broad ligament. Such hæmorrhages may be very extensive, dissecting up the whole of the pelvic peritoneum, passing on to the abdominal parietes and into the iliac fossæ, and giving rise to the symptoms of severe internal hæmorrhage. Small effusions which give rise to no urgent symptoms require no

operative treatment ; but if the patient's condition is urgent, one or other lateral vaginal fornix should be opened, the blood evacuated, and the cavity douched and plugged with iodoform gauze.

Rupture of the Perineum.—This minor accident is of frequent occurrence, but usually of small importance. It is only referred to here in order to emphasise again the importance of examining the perineum in every case after delivery, and of immediately repairing all lacerations which involve more than the skin of the fourchette. Lacerations involving the sphincter ani are of great importance, because, unless successfully repaired, troublesome rectal incontinence will ensue. The chief varieties of perineal rupture, along with the suitable methods of repair, are described upon p. 755.

Inversion of the Uterus

This condition is a turning inside out of the uterus. It is one of the rarest complications of labour, being only met with in from 1 in 180,000 to 1 in 200,000 labours. Three degrees of inversion may be described : in the first the placental site—*i.e.*, the fundus—is depressed so as to bulge to a greater or less extent into the uterine cavity (Fig. 248, *a*) ; in the second the fundus protrudes through the external os so as to enter the vaginal canal (Fig. 248, *b*) ; in the third the fundus presents at, or protrudes through, the vulva (Fig. 248, *c*), the inversion being complete. It occurs either during the third stage of labour or immediately afterwards, but it is highly probable that the process always commences during the third stage, although it may not be recognised until later.

Causes.—Inversion may occur *spontaneously*, or may be *induced* by improper methods of delivering the placenta. When *spontaneous* it may be due to precipitate labour, but the usual cause is atony of the wall of the fundus uteri ; by straining efforts on the part of the patient the relaxed area is slightly inverted, and the process then proceeds by the active part of the uterus contracting upon the inverted part and driving it onwards towards the cervix. It is also stated that spontaneous inversion may be started during the second stage of labour by traction exerted upon the placental site

through a relatively or absolutely short umbilical cord. (The cord is said to be relatively shortened when coiled round the body or limbs of the fœtus.) It is, however, difficult to believe that traction through the cord upon the wall of an actively contracting uterus could cause inversion.

Inversion may be *induced* during the third stage by endeavouring to deliver the placenta by pressure on the fundus or by traction on the cord, when the uterus is relaxed. It is probable that the process is merely started in this way, and is then carried on spontaneously by uterine contractions.

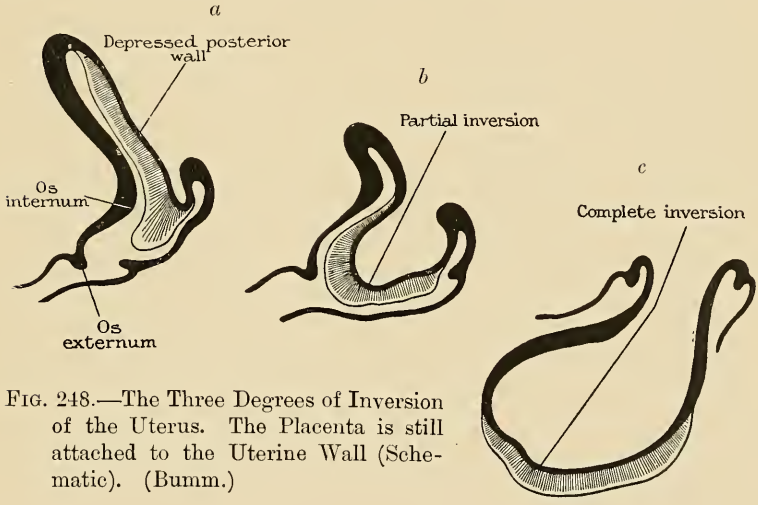


FIG. 248.—The Three Degrees of Inversion of the Uterus. The Placenta is still attached to the Uterine Wall (Schematic). (Bumm.)

Inversion is usually produced rapidly, but sometimes appears to occupy several days for its completion.

Symptoms.—Pain is a constant symptom. In the second and third degrees well-marked symptoms of shock also occur, and the pain becomes expulsive in character. There is usually hæmorrhage, but it is very variable in amount, and seldom profuse. The placenta usually remains attached to the inverted fundus; when it has been detached before inversion the risks of profuse bleeding are much greater.

The *diagnosis* of this accident is not difficult if the patient is seen soon after it has occurred. In the first degree it may be possible to palpate the fundal depression through the lax abdominal walls. When the fundus has been expelled into

the vagina, abdominal examination shows that the body of the uterus has disappeared from its normal position, and the cup formed by the upper end of the inverted organ may sometimes be felt with the fingers ; on vaginal examination the firm round swelling protruding through the cervix, and usually covered by the placenta, will then be recognised without difficulty as the inverted fundus. Diagnosis in the third degree is a simple matter when the placenta remains attached ; but a number of cases have been recorded in which, the placenta being detached, the inverted uterus has been amputated in the erroneous belief that it was a fibroid polypus. Attention to the abdominal examination should prevent this mistake.

The *prognosis* is grave ; death may occur from hæmorrhage or from shock, which may even prove fatal after a reduction of the displacement. In some cases, on the other hand, the condition may remain undiscovered, giving rise to no urgent symptoms ; it then passes into the phase of *chronic inversion*, which is dealt with in text-books of gynæcology.

The *treatment* consists in the immediate reduction of the displacement by taxis ; after careful antiseptic preparation by shaving and douching, the organ should be reinverted, beginning at the cervix, and gradually returning first the cervical part of the uterus, and last the fundus. The patient is anæsthetised, and one hand is placed upon the abdomen and two fingers are pressed down into the inversion ring so as to steady it, while the organ is gradually replaced with the fingers of the other hand introduced into the vagina. When the displacement has been completely returned, a hot intra-uterine antiseptic douche should be given, partly for disinfection and partly to promote uterine contraction. The uterus should be continuously massaged and ergot administered to counteract the tendency which these cases show to inertia, and resulting risk of recurrence of the inversion. In the second and third degrees the placenta should be removed before commencing the replacement, in order to diminish the bulk of the body to be returned through the inversion ring ; this is unnecessary in the first degree. Occasionally the uterus cannot be returned by taxis ; hot douches should then be used and continuous pressure applied to the inverted uterus by

packing the vagina with sterile gauze under strict antiseptic precautions. After twelve to twenty-four hours of continuous pressure, taxis may be repeated and will probably prove successful.

Ante-partum Hæmorrhage

By some writers the term ante-partum hæmorrhage is used to include all cases of hæmorrhage occurring either in connection with pregnancy at any period, or in connection with the first and second stages of labour. In this work hæmorrhages occurring before the period of fœtal viability has been reached have been already dealt with as Disorders of Pregnancy ; it is, further, more convenient from a clinical standpoint to restrict the term ante-partum hæmorrhage to cases occurring either in pregnancy after the period of viability has been reached, or during labour before the birth of the child. Slight cases of ante-partum hæmorrhage, as thus defined, may be due to such conditions as fibroid tumours or malignant disease of the cervix, and these conditions have been already sufficiently dealt with. Occasionally in the latter months of pregnancy profuse hæmorrhage may arise from rupture of a varicose vein in the vaginal wall or in the vulva. These cases are, however, quite exceptional and as a rule severe hæmorrhage at this period is due to bleeding *from the placental site*, and it is with these cases that this section is solely concerned.

Cases of ante-partum hæmorrhage, as thus defined (*i.e.* as bleeding from the placental site), are divided into two classes, the basis of classification being the situation of the placenta. In one class the placenta occupies the normal position—*i.e.* it is implanted upon the uterine wall entirely above the level of the lower uterine segment ; ante-partum hæmorrhage is in this class due to premature separation of the placenta, from local or general disease, or from traumatism. In the other class the placenta occupies some part or the whole of the lower uterine segment ; ante-partum hæmorrhage in these cases will necessarily occur independently of accident or disease, because the changes which normally take place in the lower segment before and during labour inevitably cause the placenta to be detached

from it. The former are known as cases of *Accidental Hæmorrhage;* the latter as cases of *Placenta Prævia* or *Unavoidable Hæmorrhage.* It must be borne in mind that the essential difference between them is the position of the placenta in the uterus, for traumatism and disease are not limited to the class of so-called accidental hæmorrhage, but are quite as likely to affect an abnormally situated placenta as one normally situated.

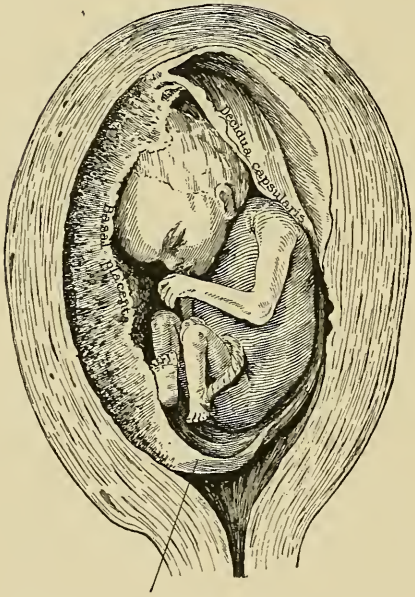


Fig. 249.—Basal Placenta Prævia; the part of the Placenta which is attached to the Lower Uterine Segment is developed upon the Decidua Basalis. (Webster.)

Causation. — 1. We have first to inquire, what are the causes which lead to the *implantation of the placenta in the lower uterine segment?* Recent observations have made it clear that there are two different ways in which it may occur: (1) the fertilised ovum may become imbedded in the lower part of the uterus when it first enters this organ, instead of, as is usually the case, at the fundus; this explanation was commonly applied to all cases until a few years ago; (2) after implantation of the ovum in the normal position, the placenta may so develop as to become attached in part to the lower uterine segment. Cases of the first kind are characterised by the formation of the decidua basalis, wholly or partly, upon the part of the mucosa which covers the lower uterine segment. In cases of the second kind, the placenta is developed in whole or in part, in connection with the decidua capsularis instead of the decidua basalis; as the ovum grows large enough to fill the uterine cavity, decidua capsularis and decidua vera fuse, and a part of the

placenta thus becomes attached to the uterine wall over the lower segment. The former may be conveniently called *basal placenta prævia* and is shown in Figs. 85, 249 and 250; the decidua capsularis can be clearly seen in the upper part of Fig. 249, and it is obvious that the placenta is formed, not upon it, but upon the decidua basalis. The latter may conveniently be called *capsular placenta prævia*, and is shown

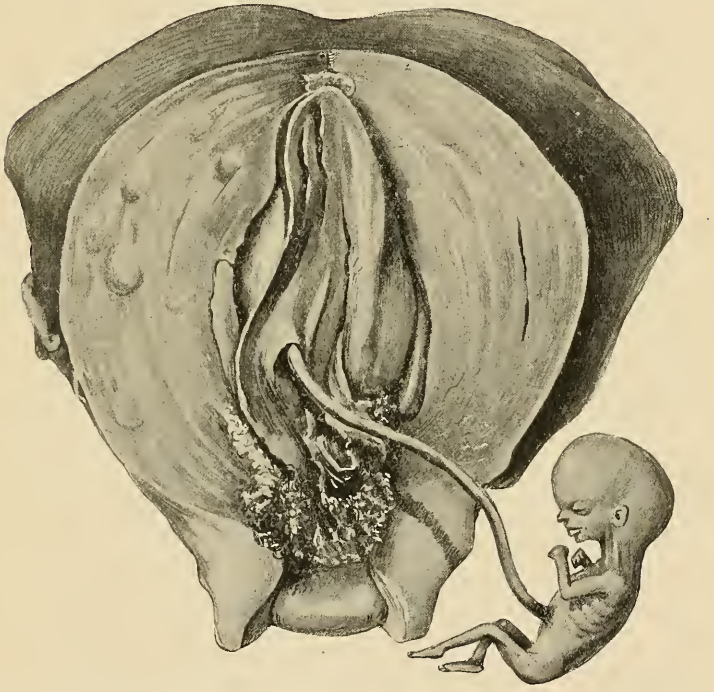


Fig. 250.—A Gravid Uterus with a Fibroid Tumour. The Placenta is situated entirely in the Lower Uterine Segment. (Willey.)

in Fig. 251; here in a three months' ovum it is seen that the decidual space persists and a portion of the placenta has developed upon the decidua capsularis on either side of the decidua basalis. In this specimen Webster described the part of the decidua capsularis upon which placental formation has occurred as closely resembling in vascularity and general appearance the decidua basalis adjacent to it. At a later stage of pregnancy a portion of the capsular placenta would

lie upon the lower segment and cover the internal os. This part of the decidua capsularis probably fuses firmly with the decidua vera, to which it becomes apposed; accordingly, when detachment of this portion of the placenta occurs, the plane of separation will pass through the well-developed

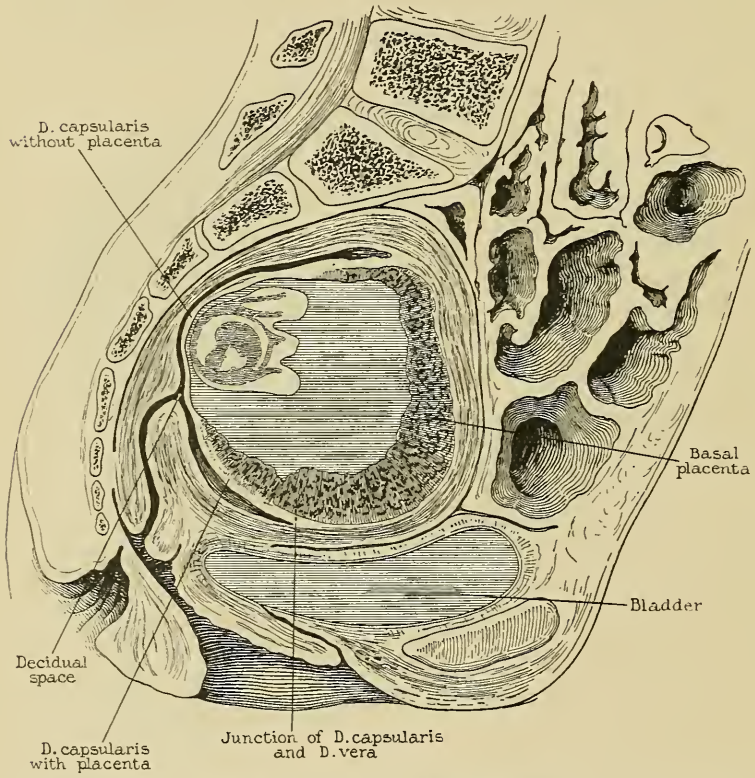


FIG. 251.—Capsular Placenta Prævia, Lateral Variety. From a Frozen Section. (Clarence Webster.)

cavernous layer of the decidua capsularis, leading to more or less serious hæmorrhage.

It seems probable that further observation will show that cases of complete placenta prævia are always basal; cases of partial or marginal placenta prævia may be either basal or capsular. It is possible that some cases are partly basal and partly capsular.

The explanation cannot be carried further than this;

we do not know what are the conditions which lead to the formation of a capsular placenta, or to the original implan-

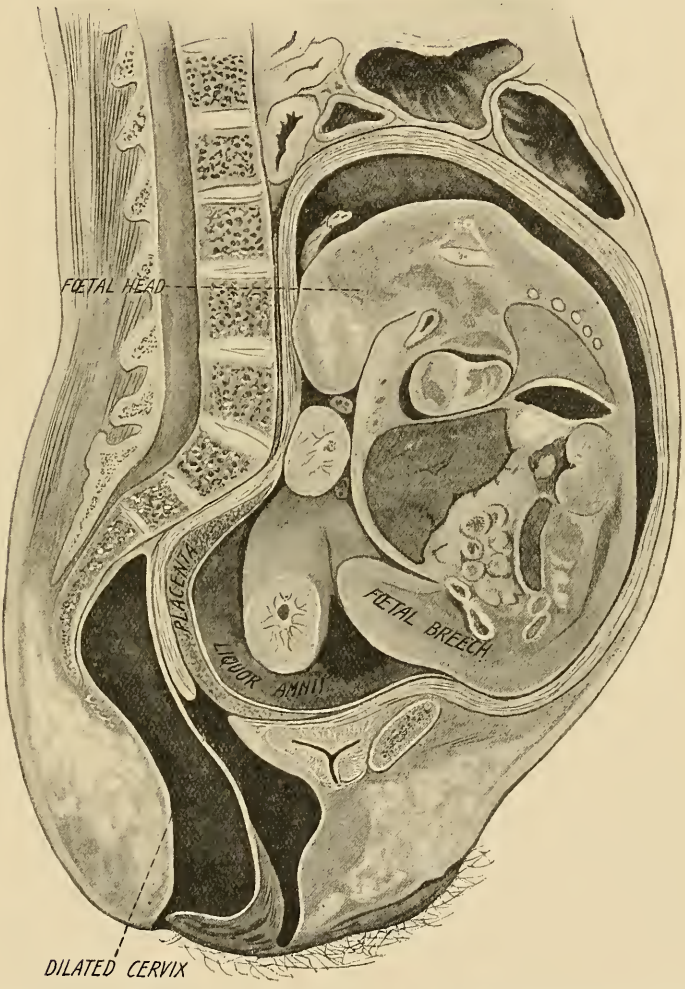


FIG. 252.—Frozen Section of a Woman who died of Hæmorrhage due to Placenta Prævia. The cervix is partly dilated, the placenta prævia is lateral, the fœtus presents by the breech. (Barbour's Anatomy of Labour.)

tation of the ovum upon the lower part of the uterine wall instead of near the fundus. Clinical evidence shows that multiparity, especially when associated with rapid child-

bearing, is a powerful predisposing cause ; there is a certain amount of evidence also that chronic endometritis and fibroid tumours may stand in the same relation (Figs. 85 and 250). It will be observed that each of these three conditions is associated with enlargement of the uterine cavity. Under normal conditions the uterine cavity is potential only ; when dilated to form an actual cavity it is obvious that the fertilised ovum may descend into the lower segment before it becomes embedded. The placenta itself is frequently abnormal ; extensive areas of degenerated villi may often be found (*placental infarcts*), and the cord often has a marginal or velamentous insertion. The nutrition and development of the fœtus are unaffected.

Given a low implantation of the placenta it is impossible for labour to take place without hæmorrhage, for when the lower uterine segment dilates and the cervix opens during the first stage, the placenta will inevitably become in part or wholly detached, and bleeding will occur from the lacerated placental vessels in the uterine wall (Fig. 252). Hence this kind of ante-partum hæmorrhage is often named *Unavoidable Hæmorrhage*. But the low position of the placenta is not the only possible cause of hæmorrhage in such cases, for traumatism or local disease, such as will be described in the next paragraph, may affect a placenta prævia, and, by causing partial detachment, may lead to hæmorrhage.

2. With regard to *accidental hæmorrhage* considerable uncertainty still exists as to the relative importance of injury and disease in causing separation of the normally situated placenta. Instances are rare in which it can be attributed solely to direct injury—*e.g.* a kick on the abdomen or a fall ; but there is no doubt that such injuries may cause separation of a healthy placenta from its normal attachments. It is probable that a sudden rise in intra-abdominal pressure, produced for instance by an unusual muscular effort or severe coughing or vomiting, may detach the placenta, when local disease weakening its attachments exists, and therefore in these cases both injury and disease are factors in causation. In other cases the hæmorrhage is absolutely spontaneous and must be attributed solely to disease. It is somewhat of a reproach to obstetrics that

current knowledge of the nature of the diseases which cause accidental hæmorrhage is so unsatisfactory and incomplete. The most that can be said is that, upon evidence not always convincing, the following are believed to be the most important :

Chronic Bright's disease.
Anæmia.
Purpura.
Syphilis.
Cardiac disease (especially mitral lesions).
Fibroid tumours of the uterus (when submucous or interstitial).
Decidual endometritis.

It must be admitted that, except in the case of chronic nephritis, the evidence that these conditions alone can cause accidental hæmorrhage is inconclusive. Histological examination of the uterine wall after death, or better after its removal by operation, has so far failed to reveal any structural changes to which the hæmorrhage may be attributed. In cases of concealed accidental hæmorrhage interstitial bleeding has been found in the muscular wall, but this is probably the result of over-distension of the organ and is not related to the original hæmorrhage from the placental site. It has also been suggested that a very short cord may be the cause of hæmorrhage during the second stage of labour, from traction on the placenta. It is believed that nervous shock may initiate it by exciting a sudden and violent uterine contraction, sufficiently powerful to cause slight separation of the placenta. Multiparity is a powerful predisposing cause, and the great majority of cases occur in feeble and debilitated women. It is accordingly much commoner in hospitals than in private practice.

3. The question next arises, why does ante-partum hæmorrhage always occur when the placenta invades the lower uterine segment, and not when it occupies the normal situation ? The answer will be found in the different functions of the upper and lower parts of the body of the uterus. The upper part plays an active *rôle* in labour, undergoing intermittent contractions, and progressive and continuous retraction. The attachment of the placenta to

this part of the uterine wall is not affected by the normal contractions of the first and second stages, for although these doubtless entail a slight diminution in the superficies of the uterine wall, this diminution is not sufficient to disturb the placental attachments. Retraction causes more extensive reduction of the superficies of the uterine wall, but until the body of the fœtus has been expelled retraction is only slight in normal labour, and therefore the placenta is able to maintain its attachments. The lower part of the uterus, on the other hand, plays a passive *rôle ;* no contractions occur in it, but it gradually becomes stretched during the stage of dilatation so that its superficial area is greatly increased, and its shape altered from that of a section of a hemisphere to that of a cylinder. The placenta is unable to expand in correspondence with the stretching of its site of attachment, and the consequence is that the uterine wall becomes progressively torn away from the placenta, and hæmorrhage then occurs from lacerated utero-placental vessels. Hæmorrhage is, accordingly, said to be *unavoidable* in placenta prævia.

But how can we account for the occurrence of bleeding *before* the onset of labour, in cases of placenta prævia ? It is possible that, in a certain proportion, disease of the placenta or traumatism—direct or indirect—may explain it. In may cases, however, the bleeding appears to be due solely to the abnormal situation of the placenta. A physiological explanation of these cases has been suggested by Pinard—viz. that during the last few weeks of pregnancy the intermittent uterine contractions become gradually stronger (they are certainly more easily palpable), although they remain painless and unperceived by the mother. Upon the lower segment these contractions exercise a dilating force, which may be sufficient to cause slight separation of the placenta and more or less profuse hæmorrhage. In support of this explanation may be cited the clinical fact that a degree of dilatation of the internal os sufficient to admit one finger is met with in the last few weeks of pregnancy, frequently in multiparæ, occasionally in primigravidæ. Webster has suggested an anatomical explanation—viz. that when hæmorrhage occurs before term we have to do with a *capsular placenta prævia*, in which the fusion between

decidua vera and decidua capsularis has not been very firm ; hence separation of the two decidual layers readily occurs, leading to hæmorrhage.

Morbid Anatomy.—1. *Placenta prævia.*—The extent of the area which the placenta occupies in the lower segment varies, and three degrees are accordingly distinguished : (1) The placenta may occupy the whole of the lower segment, its centre being situated approximately over the internal os ; this is called *central placenta prævia* (Figs. 250 and 253). In clinical practice, cases are called *central* in which the placenta completely covers the os and the margin cannot be reached by the finger. (2) It may occupy approximately one-half of the lower segment, the placenta covering the undilated internal os ; this is called *lateral placenta prævia* (Figs. 252 and 254). (3) It may be attached only to the upper part of the lower segment on one side, so as to lie completely above the level of the internal os ; this is called *marginal placenta prævia* (Fig. 251). It will be obvious that in each variety the placenta to a greater or less extent also overlaps the *safe zone*—*i.e.* the uterine wall above the upper limit of the lower segment. The amount of hæmorrhage met with depends mainly, if not entirely, upon the extent of placental

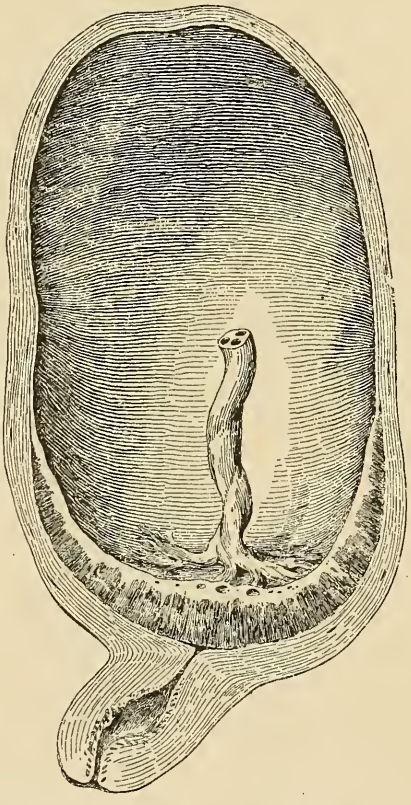


Fig. 253.—Central Placenta Prævia ; the Placenta occupies the whole of the Lower Uterine Segment. (Bumm.)

site which is laid bare in the process of dilatation ; accordingly there will generally be the greatest amount with *central*, the least with *marginal*, placenta prævia. And further, inasmuch as the central variety offers a mechanical obstacle both to the expulsion of the fœtus and to the

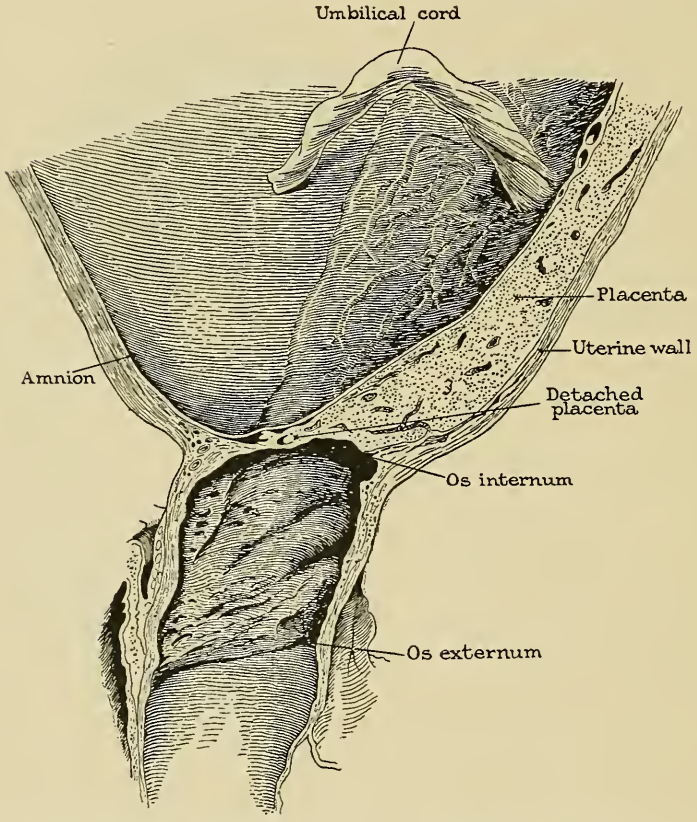


Fig. 254.—Lateral Placenta Prævia; the Placenta overlaps the Os Internum, which is partly dilated. From a Frozen Section. (Ahlfeld.)

performance of any intra-uterine operation, it is the most difficult to deal with.

From clinical evidence there is reason to believe that the wall of the lower segment is unusually weak and friable when the placenta is inserted upon it ; no abnormal thinning has been detected in frozen sections (Fig. 252), but the develop-

ment in it of the large sub-placental venous sinuses probably lessens the resisting power of the uterine wall. The practical

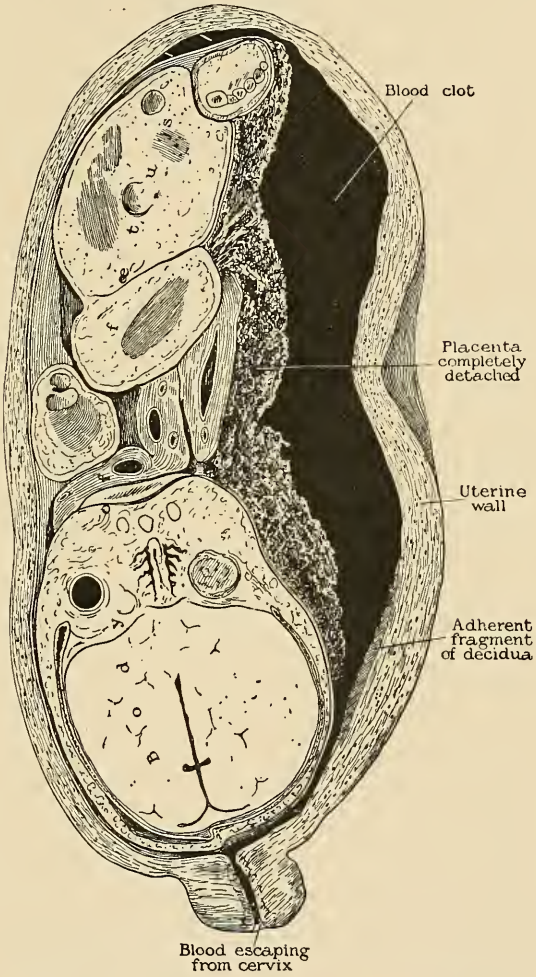


FIG. 255.—Concealed Accidental Hæmorrhage. (Varnier.)

result is that rupture of the lower segment is very readily caused by intra-uterine manipulations.

2. *Accidental Hæmorrhage.*—It is rarely the case that the entire placenta is separated from the uterine wall in accidental hæmorrhage, although this occurrence is shown (from

nature) in Fig. 255 ; here a very large effusion was formed behind the placenta, which resulted in the death of the patient from internal hæmorrhage. Separation of a portion only of the placenta is, however, quite enough to cause very severe bleeding. Usually the effused blood escapes under the placental margin and makes its way between the membranes and the uterine wall down to the internal os, whence it passes through the cervix into the vagina. If the hæmorrhage is accompanied by labour pains, this will invariably occur, the effused blood being expelled from the uterus by the contractions.

It is, however, not uncommon for retention of blood within the uterus to occur during accidental hæmorrhage, and it will be generally observed that a considerable mass of blood-clot accompanies or immediately follows the expulsion of the placenta in a case of free external bleeding. In very rare instances, however, almost the whole of the effused blood is thus retained, leading to the condition known clinically as *concealed accidental hæmorrhage*. The most important cause of this retention is probably weakness, loss of tone, or loss of excitability of the uterine muscle, which results in complete absence of uterine contractions. Accordingly the uterus distends easily to accommodate the effused blood, and in time the muscle becomes completely paralysed from great over-distension, and unable to respond to any stimulus whatever. Other conditions may favour the occurrence of concealed hæmorrhage, such as (1) morbid adhesion of the placental margin, leading to the formation of retro-placental hæmatoma ; (2) morbid adhesion of the membranes around the internal os, preventing the blood from entering the cervical canal. Sometimes, in concealed hæmorrhage, the amnion is ruptured by the effused blood, so that bleeding takes place into the amniotic sac ; more often it is found between the placenta or membranes and the uterine wall. There is usually a little external bleeding in concealed accidental hæmorrhage (Fig. 255). In placenta prævia there is no concealed bleeding.

It will be clear from the above that, in addition to *external* and *concealed* accidental hæmorrhage, a third variety, partly external and partly concealed, may be described.

Symptoms and Influence upon Labour.—1. There is only one symptom of *placenta prævia*—viz. visible hæmorrhage. This symptom may make its appearance in pregnancy, but seldom before the twenty-eighth or thirtieth week, up to which period nothing occurs to indicate the existence of the abnormality. There is no doubt that many cases of abortion occurring between the formation of the placenta and the period of fœtal viability may be due to placenta prævia. In these cases, however, the treatment is simply that of any abortion; the position occupied by the placenta cannot be clinically recognised, and does not influence the question of management. From a practical standpoint they therefore belong to a different class from that now under consideration. If a placenta prævia successfully passes the fourth month, there is apparently little tendency to further hæmorrhage until the twenty-eighth week is reached. The bleeding is not accompanied by pain, unless labour starts simultaneously; the effused blood is arterial and may be profuse in quantity. The onset is usually spontaneous, and often occurs during sleep; but, as already explained, a history of traumatism may be met with. The first attack may cease spontaneously in a few hours, but there is a marked tendency to recurrence, and by repeated hæmorrhages at intervals, the patient may become exsanguine before labour sets in.

The general course of labour is unfavourably affected by placenta prævia as follows: (1) Labour is usually premature, and as the capacity of the lower uterine segment is diminished, the presentation is frequently abnormal; in 352 cases recorded by Bürger and Graf the presentations were—vertex 69·2 per cent., transverse 21·1 per cent. breech (all varieties) 9·4 per cent., but the proportion of transverse presentation in this series is probably unusually high; (2) the stage of dilatation is prolonged owing to the deficient formation or entire absence (in central cases) of the natural dilator—the bag of waters; (3) when the hæmorrhage is severe, uterine exhaustion (secondary inertia) may set in; (4) interference is frequently required to arrest the bleeding temporarily or to terminate labour rapidly; (5) consequently there is increased risk of serious laceration of the cervix and lower uterine segment; (6) puerperal

septic infection is a relatively frequent sequel, being accounted for partly by the frequency of operative interference and of serious cervical tears, and partly, as is well recognised from diminution in the patient's powers of resistance to infective processes, brought about by loss of blood ; (7) the life of the fœtus is jeopardised by premature separation of the placenta, which may cause asphyxia (p. 633), by prolapse of the cord, or by the interference required to terminate labour.

During the first stage of labour hæmorrhage proceeds either continuously or in irregular gushes ; or the vagina may become filled up with masses of blood-clot. Towards the end of this stage the hæmorrhage abates, because the presenting part compresses the placental site in passing through the dilated lower segment. After the expulsion of the body the placenta becomes completely detached, and is usually expelled immediately after the child. Unless secondary uterine inertia sets in, the bleeding then ceases.

2. *Accidental hæmorrhage* is characterised either by *external bleeding* or by the signs and symptoms of *concealed uterine hæmorrhage.* It is probable that many cases of abortion occurring after the third month are due to detachment, by traumatism or disease, of the normally situated placenta, and these are technically cases of accidental hæmorrhage. It is, however, convenient, as already explained, to restrict this term to cases occurring after the period of viability of the fœtus has been attained. It is therefore obvious that in cases of accidental hæmorrhage, with *external* bleeding coming on during the seventh or eighth month, the symptoms will closely resemble those of placenta prævia. Even if a history of traumatism is obtained, it does not necessarily follow that the case is one of accidental hæmorrhage ; the differential diagnosis can only be made in the manner to be described later on.

In *concealed* accidental hæmorrhage we have one of the most serious accidents that can possibly happen to a pregnant woman. In a severe case there is a fairly characteristic train of signs and symptoms, which are due to two factors : (1) Loss of blood, (2) over-distension of the uterus. The general symptoms caused by internal bleeding have been referred to in connection with tubal pregnancy (p. 190), and

need not be described again. The occurrence of minor degrees of concealed hæmorrhage may sometimes be diagnosed by noting, in an apparent case of external hæmorrhage, that the degree of constitutional disturbance is disproportionate to the amount of blood lost. In a severe case of concealed bleeding the constitutional disturbance is profound. Over-distension of the uterus causes severe, continuous, and increasing abdominal pain, combined with shock. The uterus itself increases rapidly in size, and in a few hours may become large enough to displace the diaphragm and embarrass the respiration. On examination *per abdomen* it will be observed that the uterus is unduly large, and tender, and sometimes so tense as to feel almost wooden in consistence ; no contractions can be made out ; the fœtal parts cannot be detected nor the sounds of the fœtal heart heard. If progressive increase in size of the uterus, in the course of a few hours, can also be made out, the presence of concealed bleeding is certain. On vaginal examination a little bleeding from the uterus will usually be detected, although in rare cases there is none. The temperature will be subnormal, the pulse will be rapid—over 120 ; there will be pallor, or absolute blanching of the skin and mucous membranes.

Concealed accidental hæmorrhage is invariably accompanied by complete paralysis of the uterine muscle ; the cervix is usually undilated, and not only are there no spontaneous uterine contractions, but it is extremely difficult to obtain any response to the ordinary methods of excitation.

Clearly a certain resemblance exists between this condition and tonic uterine contraction (see p. 449). In concealed hæmorrhage, however, the uterus is larger than normal, but in tonic contraction it is much smaller ; and while signs of internal hæmorrhage are conspicuous in the former, in the latter the signs are those of 'obstetric exhaustion' with some rise of temperature. Lastly, in tonic contraction the cervix is always considerably dilated, and the presenting part impacted, while in concealed hæmorrhage the cervix is small and the presentation obscure. Accordingly, errors in diagnosis need not occur.

In *external* accidental hæmorrhage the course of labour is unfavourably affected, in very much the same manner as in

placenta prævia. But much greater variation in the amount of hæmorrhage is met with in the former than in the latter ; many cases of accidental hæmorrhage are trivial, but placenta prævia is nearly always serious. Labour is usually premature ; tedious from partial uterine inertia ; dangerous to the mother on account of loss of blood, and on account of the frequent necessity for operative interference increasing the risks of sepsis ; dangerous to the child from risks of asphyxia by premature separation of the placenta, or of injury during intra-uterine operations. Generally speaking accidental hæmorrhage does not show the same tendency to recurrence as placenta prævia. Although recurrences either before labour or when labour sets in are common, they are by no means invariable, as in the case of placenta prævia. Cases are accordingly not infrequent, in which, after a single slight or moderate bleeding of the accidental type, pregnancy is completed and labour brought to a close without further hæmorrhage.

Differential Diagnosis.—The differential diagnosis between placenta prævia and accidental hæmorrhage can only be made by recognising in the former that the placenta occupies the lower uterine segment. It is said that this may sometimes be done by palpation and auscultation *per abdomen*, but this is doubtful. When the cervix is closed it may be surmised that the placenta occupies the lower segment from the consistence of the uterine wall as felt through the vaginal fornices ; an unusual extent of soft boggy resistance may here be felt, obscuring the presenting part, and making the detection of ballottement difficult. The presence of the placenta in the lower segment interferes with the descent of the presenting part, and renders engagement of the head in the brim before labour impracticable. If, therefore, the head is found engaged, the case is more likely to be one of accidental hæmorrhage.

The only conclusive method is to pass the finger through the internal os, when the placenta can be recognised by direct touch. If the edge of the placenta is within reach its recognition by the finger is fairly easy, from its rounded contour and the sharp line of transference from placenta to membranes. When the edge cannot be reached a little care is required to distinguish retained blood-clot from placental

tissue, the much greater friability of the former being the chief point of distinction between them. This method is, of course, only applicable when the internal os has begun to dilate; but after a severe hæmorrhage there is usually sufficient dilatation for the diagnosis to be made in this manner; during labour no difficulty will be encountered except in marginal cases early in labour, when the placental edge may lie so far away from the os as to be beyond the reach of the finger. When the placenta cannot be felt in the lower segment the case must be regarded as one of accidental hæmorrhage. Cases of concealed hæmorrhage are never due to placenta prævia.

Treatment before Labour.—Before labour, slight cases of *accidental hæmorrhage* should in the first place be treated by palliative measures. Complete rest in bed should be enforced, and continued for at least a week after all bleeding has ceased; a daily aperient, and light diet without stimulants, should be enjoined. Sedatives will be indicated in most cases, some form of opium being undoubtedly the most useful. Ergot has been advised in small doses—10 to 20 minims of liquid extract three times a day; but it is very doubtful whether it exerts any appreciable effect. A hypodermic injection of $\frac{1}{4}$ grain of morphia may be given in the first instance, and repeated in doses of $\frac{1}{8}$ grain if the bleeding continues. In cases where the amount of external loss is slight, a careful watch should be kept for the signs of concealed bleeding. Recurrence of bleeding does not necessarily take place, and even when labour occurs there may be no more hæmorrhage. Palliative treatment should not be continued for more than twenty-four hours, when it fails to control bleeding. After a single severe hæmorrhage, labour usually sets in spontaneously, unless the uterine muscle becomes paralysed from over-distension.

In the case of *placenta prævia*, the same line of treatment should not be adopted unless the patient can be kept under continuous observation, and assistance is available in the event of a serious recurrence of bleeding. Otherwise, labour should be at once induced, even after a single hæmorrhage, for in placenta prævia the recurrence of bleeding either before or during labour is inevitable, while in accidental hæmorrhage it is not. The best method of induction is

the use of de Ribes' bag, with version later on if necessary (*vide infra*).

Management of Labour.—The management of labour complicated by ante-partum hæmorrhage must be guided by the following principles : (1) In all severe cases the immediate indication is to control the bleeding, and then to delay delivery until there has been time for the patient to recover from the shock of a severe hæmorrhage, and for the labour to make progress ; (2) permanent arrest of the hæmorrhage can, however, only be ensured by complete *evacuation* and *retraction* of the uterus ; therefore the risk of recurrence will continue until delivery has been completed ; (3) in urgent cases the chances of the child surviving are so slight that treatment may be directed solely to the interests of the mother.

Temporary arrest of hæmorrhage is much more practicable in placenta prævia than in accidental hæmorrhage ; in the former the placental site in the lower uterine segment is accessible from the vagina, and may be subjected to direct compression in various ways ; in the latter the placental site cannot be localised and is inaccessible to direct compression. The effect of uterine contractions in the two cases is also different : in placenta prævia the lower segment is progressively dilated and the placental site progressively denuded by the uterine contractions, which accordingly tend to increase the bleeding, until that part of the placenta which occupies the lower segment is completely detached ; in accidental hæmorrhage each contraction temporarily diminishes the maternal blood-flow to the placental site, and accordingly tends for the moment to check bleeding. Uterine contractions are, in point of fact, the only means we possess of temporarily controlling accidental hæmorrhage, and treatment is therefore directed to exciting them to the greatest possible activity. In both varieties of ante-partum hæmorrhage, elevating the foot of the bed for 10 to 12 inches is believed to check the bleeding slightly and is usually practised.

Treatment of Severe Cases of Placenta Prævia.—In practically all cases of placenta prævia in which considerable bleeding has occurred, whether in labour or not, the cervix will be found to be sufficiently dilated to admit one finger or

sometimes two fingers. Two methods of treatment are then available, either of which will immediately arrest bleeding by compressing the placental site, and will also, after an interval, excite labour. These methods are (*a*) pulling down a leg so as to plug the lower uterine segment and cervix with the half-breech ; (*b*) introducing the hydrostatic dilator of de Ribes into the uterus so as to produce the same effects. Each of these methods has advantages in some respects over the other, and opinion is accordingly divided as to which should have the preference. It will be convenient first to describe these methods and then compare them as to their merits.

(A.) *Pulling down a Leg.*—If the presentation is vertex or transverse, the fœtus must be turned in order to allow of the leg being brought down within reach of the fingers passed into the cervix. As it is very desirable to avoid unnecessary internal manipulations, version should be performed by the external method if possible (p. 672) ; under anæsthesia this can usually be done, even when labour is in progress, if the membranes have not ruptured, and an anæsthetic will in all cases be required in order to pass the fingers through the cervix. A pelvic presentation having thus been produced, the vulva should first be shaved, afterwards the vulva and vaginal canal should be thoroughly swabbed first with ether soap and then with a reliable antiseptic, such as lysol (a teaspoonful to a pint), or, as an alternative, dried with sterile swabs and then freely painted over with tincture of iodine. The operator should also wear sterilised rubber gloves. The most stringent antiseptic precautions are called for, as the denuded portion of the placental site, with its large open vessels, is within the area of the manipulations, thus favouring direct absorption into the circulation, and tending to make the results of even slight degrees of infection very serious. Bi-polar combined version should therefore be avoided whenever the fœtus can be turned by the external method. When the breech has been brought over the pelvic brim it is usually easy to find a foot, if two fingers can be passed into the cervix ; the only difficult cases are those of central insertion, when the placental tissue over the os must be first torn through with the finger. The membranes should then be ruptured,

and the foot seized by the ankle and pulled down into the vagina. If the legs should be extended and the feet consequently out of reach, it is impossible at this stage of labour

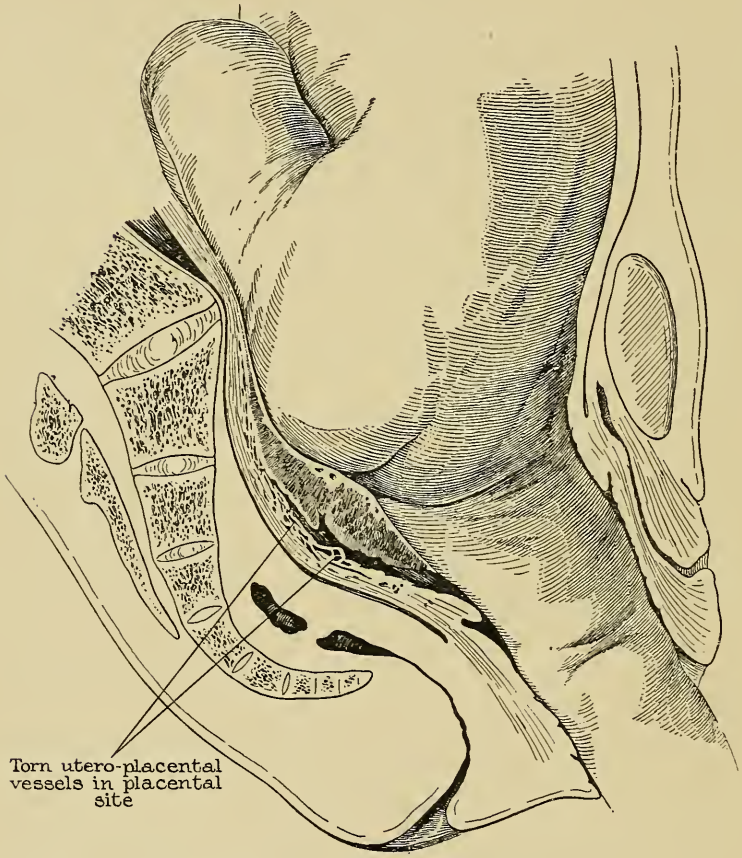


Fig. 256.—Placenta Prævia; Lower Uterine Segment and Cervix Plugged by the Half-Breech. (Bumm.)

to pull down a leg at all, and the alternative method of treatment by de Ribes' bag must be adopted.

A certain amount of fresh bleeding is necessarily caused by these manipulations, but by exerting gentle continuous traction on the foot the half-breech may be pulled down into the lower uterine segment (Fig. 256) so as to plug it firmly and directly to compress the placental site. A degree of traction

just sufficient to arrest bleeding may be kept up steadily by an assistant by means of a tape tied to the foot ; very little exercise of force is required to prevent further hæmorrhage, and great gentleness is called for because (1) it is not desirable to hurry the delivery of the child ; (2) serious laceration of the cervix running up into the lower segment and involving the placental sinuses is very readily caused, which may result in troublesome post-partum hæmorrhage, and which increases the risks of sepsis. Continuous traction may be applied by attaching a weight of 1 to 2 pounds to the foot-tape, but mechanical methods are inferior to traction by an assistant, as the latter can be regulated with nicety to the minimum force required to stop bleeding.

After a leg has been pulled down it is essential that an interval should be allowed to elapse before delivery, if there has been serious bleeding ; profuse hæmorrhage is not an indication for rapid delivery in placenta prævia, for the shock induced by rapidly emptying the uterus may prove fatal to patients already suffering from the constitutional effects of hæmorrhage. When this procedure is adopted in cases not actually in labour, effective labour pains usually begin within twelve hours ; there is no more powerful or certain method of exciting active uterine contractions. If labour has already begun the process will be expedited, but the expulsion of the body of the child should be left entirely to the natural forces, and no attempt made to deliver by traction. It will be recollected that the same rule has been already laid down for ordinary breech labour, on account of the increased risks of extension of the arms or head occurring when traction is made. In the case of placenta prævia the additional object of delay is to allow time for recovery from shock and hæmorrhage, and for the application of restorative measures to the mother. In severe cases the same restorative methods may be employed as in bad cases of post-partum hæmorrhage (p. 525).

When labour pains become effective and the body of the child is gradually expelled, no further serious bleeding will occur, for the trunk and head of the child successively plug the lower segment and compress the placental site. As soon as the child has been delivered, the third stage should be completed as rapidly as possible, for post-partum hæmor-

rhage frequently occurs from imperfect retraction, and when there have already been profuse losses of blood even a moderate amount of post-partum bleeding may prove fatal. Therefore the placenta should be at once expressed, or if this cannot be done it should be digitally removed. As a rule, expression is easy because the placenta has already been extensively detached. An antiseptic intra-uterine douche should always be used after delivery in cases of placenta prævia.

(B.) *Introducing de Ribes' Dilating Bag.*—This appliance, and the details of the method of using it, will be found fully described on p. 664, in the section on Obstetric Operations. Like the method just described, the dilator acts (1) in temporarily arresting bleeding by compressing the placental site ; (2) in exciting labour pains. As the uterine contractions become effective the cervix is mechanically dilated to the size of the broad end of the bag (see Fig. 299). It is unnecessary to alter the position of the child, as the method is applicable in all presentations. Just before introducing the bag the membranes should be ruptured so that the dilator will lie within the amniotic cavity. It is therefore easier to introduce it in cases in which the edge of the placenta is within reach. When the insertion is *central* the placental tissue over the os must be torn through with the finger, and the opening thus made stretched until it is large enough to admit the bag. The introduction of the dilator under these circumstances is undoubtedly difficult. When it has been introduced and inflated gentle traction may be exercised, *preferably by the hand*, in order to keep up continuous compression of the placental site.

As a means of arresting hæmorrhage the bag is effective ; but it is inferior to pulling down a leg as a means of exciting labour pains. When traction is used, the bag will often dilate the cervix without inducing effective labour pains at all. When the cervical canal has been dilated to the full size of the bag, the latter passes out of the uterus into the vagina. If the uterus is now contracting well, so as to drive the presenting part well down into the cervix, bleeding will not recur to any serious extent. But if the uterus is inactive, the removal of the compressing force may lead to a sudden profuse loss of blood when the bag passes into the vagina.

In this respect, therefore, the method is decidedly inferior to pulling down a leg, for in the latter compression is necessarily maintained until the body of the child has been delivered.

After the bag has done its work in dilating the cervix it is usually necessary to adopt some method of operative delivery, such as forceps or internal version, and the patient must be most carefully watched in order that there may be no delay in doing what is required if bleeding recurs after the expulsion of the bag. When the bag has been expelled and the uterus is inactive, delivery must not be delayed ; forceps extraction under anæsthesia is the method of choice in such cases. Delay may be followed by further profuse bleeding which greatly increases the risks of the subsequent extraction of the child. In forceps operations the greatest care is called for, and delivery should be effected slowly ; as the head is pulled down into the pelvis the bleeding will cease from efficient compression of the placental site.

Comparison of Methods.—For the *dilating bag* the cases most suitable are those of *lateral* and *marginal* placenta prævia, where the membranes are within reach and the bag can be pushed through them. Cases of *central* insertion, on the other hand, should always be treated in preference by version for the following reasons : (*a*) the child dies before delivery in almost all central cases owing to the extensive separation of the placenta ; (*b*) the amount of bleeding is always severe and the condition demands such methods of treatment as will minimise subsequent hæmorrhage ; (*c*) version is the easiest method of trans-placental delivery. Having brought down the half-breech in a central case, delivery should not be at once completed : the more serious the condition of the mother the more necessary is it that this precaution should be observed. The time gained after arrest of bleeding should be spent in restorative measures, and delivery may then occur spontaneously later on. Continuous gentle traction on the breech may be necessary to arrest bleeding completely.

It may be said that all cases of placenta prævia are suitable for *version*. The reason why it is not in all cases adopted is that the fœtal mortality with this method is higher than with the hydrostatic bag. On the other hand the risks to the mother are less with version. The general

rule which should be observed is that the bag may be used in the less severe class of cases where the amount of bleeding has been comparatively small. In all cases where the amount of bleeding has been severe, and in central cases even when the bleeding has not at the time been alarming, version should be preferred. The conditions in the latter involve maternal risks so serious as to forbid us to allow them to be increased by adopting measures designed in the interests of the child alone.

It must further be observed that when the bag is used the patient requires continuous medical supervision, for its expulsion may be immediately followed by profuse bleeding. With version, however, delivery may occur spontaneously without further loss of blood. Under the conditions generally found in private practice the method of version, for this reason also, is to be preferred.

Treatment of Slight Cases of Placenta Prævia.—In slight cases two methods are available, much simpler, and involving much less interference than those just described; they are (*a*) plugging the cervix and vagina, and (*b*) rupturing the membranes. *Plugging* is carried out in the manner to be described in connection with the treatment of accidental hæmorrhage (p. 508). Large quantities of gauze are required and the upper part of the vagina must be tightly packed if the plug is to be effective. This method is mainly applicable to cases in which labour has not begun or the cervix is not sufficiently dilated to admit two fingers. Under these conditions it will arrest bleeding, and in some cases also will start labour pains. The chief objection to it is the difficulty of maintaining efficient asepsis. That this is a practical objection is shown by the fact that even in lying-in hospitals cases treated by plugging show a higher percentage of septic complications than those treated by any other method. It should therefore not be adopted except in an emergency.

Rupture of the Membranes.—This method is very useful when the head or breech presents, the placenta is marginal or lateral, and the amount of bleeding slight; unless labour is already in progress the conditions for its performance are not entirely favourable, for as a means of inducing labour it is unreliable. Free escape of the liquor amnii permits the presenting part to descend completely into the lower uterine

segment and fill it so as to compress the placental site ; at the same time the force and frequency of the uterine contractions are increased. Care must be taken that a loop of cord does not become prolapsed. If the shoulder presents it is contra-indicated. If the breech presents it should be followed by pulling down a leg as soon as sufficient dilatation has been accomplished. Whenever it is clear that the child is dead delivery may be rendered easier by reducing the size of the head by craniotomy.

Cæsarean Section in the Treatment of Placenta Prævia.—A certain amount of experience has been gained during the last few years of the performance of Cæsarean section in cases of placenta prævia. This operation has been done chiefly in cases of central insertion, for in these the mechanical difficulties of delivery *per vias naturales* are the greatest, and the degree of hæmorrhage is always severe. It may be considered in all cases in which there has been serious hæmorrhage, and in which from the position of the placenta it is anticipated that delivery cannot be effected without further serious loss of blood. In such cases Cæsarean section, performed after the first attack of bleeding has occurred, offers almost the only chance of the survival of the child, and is probably less dangerous to the mother than delivery by the natural channels. At the same time it must be remembered that delivery by Cæsarean section cannot be effected without the loss of a considerable amount (one half pint) of blood. In addition, the amount of shock attending an abdominal operation is certainly greater than that attending delivery after pulling down a leg. Cæsarean section is not here contra-indicated by death of the child, for the operation is mainly undertaken in the maternal interests. In order to reduce operative shock the operation should be performed by the so-called " shockless " method, *i.e.*, by the use of local anæsthesia supplemented by a minimum amount of an innocuous general anæsthetic such as gas and oxygen. Intravenous saline transfusion will usually be required either before or during the operation.

Treatment of Accidental Hæmorrhage.—1. *When the hæmorrhage is external.*—In the early stages of labour, the cervix being closed or only large enough to admit two fingers, two methods of treatment are applicable—viz., vaginal plug-

ging and rupture of the membranes. The former is the method introduced and advocated at the Rotunda Hospital, Dublin, and now generally accepted and practised. The object in view is twofold—firstly, to stimulate the uterus and so induce effective labour pains; secondly, to prevent further hæmorrhage. The vaginal plug does not directly control bleeding, as in the case of placenta prævia; but it is claimed for it that, by preventing the escape of the effused blood, when the uterus is actively contracting, the intra-uterine pressure will be raised to a point at which it equals or exceeds the blood-pressure in the placental sinuses, and accordingly the bleeding will cease spontaneously. It is clear that this effect will not be produced unless the plug excites effective uterine contractions. The plugging is carried out as follows: The vulva should be shaved and, after thorough antiseptic douching and swabbing, the vaginal canal is tightly plugged from the fornices to the vulva with strips of antiseptic gauze; an abdominal binder tight enough to compress the uterus is next applied; finally a large pad of wool is placed over the vulva, and a bandage carried tightly from the binder behind, over the vulval pad, and fixed to the binder in front. Full doses of ergot are also given by the mouth or by subcutaneous injection. Unruptured membranes are of great assistance in maintaining intra-uterine tension. If uterine contractions are not powerfully excited, this treatment may convert the case into one of concealed hæmorrhage by preventing the escape of effused blood. This untoward result does undoubtedly occur, but experience shows that plugging by this method rarely fai'ls to excite effective contractions.

It has been already mentioned that vaginal plugging is difficult to carry out under complete asepsis, and that septic complications are frequent after its use. The risk of sepsis is probably less in accidental hæmorrhage than in placenta prævia on account of the low position of the placenta in the latter. The efficiency of the method in suitable cases and the simplicity of its requirements render it of real value in accidental hæmorrhage.

Rupture of the membranes is the other alternative at this stage; its object is to excite effective contractions and thus accelerate labour. This effect is, however, less

certainly produced than by vaginal plugging. It should only be used at this stage if the bleeding is slight or has ceased, and the amount of blood which has been lost is inconsiderable. Before rupturing the membranes a head presentation should be produced by external version if any other part presents. Afterwards, a tight abdominal binder should be applied, and full doses of ergot given until effective pains have been excited.

The matter may therefore be summed up by saying that in the early stages severe cases of external accidental hæmorrhage should be treated by plugging, slight cases by rupturing the membranes.

In the further management of labour it must be recollected that in many cases accidental hæmorrhage ceases spontaneously, and after a severe loss at the beginning of labour no more bleeding may occur. Or if the bleeding recurs it is not necessarily in large quantity. In this respect the conditions are very different from placenta prævia, in which hæmorrhage continues throughout the stage of dilatation unless checked by treatment. When the bleeding has ceased or is inconsiderable and the cervix is sufficiently dilated, de Ribes' bag may be used for dilating the cervix so that delivery may be rapidly completed by forceps or version.

2. *When the hæmorrhage is concealed.*—In severe cases of concealed hæmorrhage there is complete uterine inertia, and it is almost impossible to induce *effective* labour pains owing to paralysis of the uterine muscle from over-distension. Two lines of treatment have to be considered, and the choice is often difficult, requiring great care and judgment. (1) The vagina may be plugged and a binder applied in the hope of exciting pains, and the attention then devoted to restoring the patient's strength by administration of stimulants, saline enemata, or saline transfusion. In the absence of skilled assistance, and in surroundings unsuitable for serious operative measures, this is probably the best treatment to pursue. (2) In hospital practice, and when the patient's surroundings are suitable for a major operation, the case may be treated by Cæsarean section or by the removal of the entire unopened uterus. Since the uterus in concealed hæmorrhage is nearly always an organ exhausted by repeated child-bearing, it may be urged that it should be removed in

the mother's interests. If removed unopened, there is probably less fresh loss of blood than if removed by the usual procedure in Cæsarean hysterectomy (p. 735). Where such an operation is performed the precautions described in connection with Cæsarean section for placenta prævia must be strictly observed. As may be expected, a high maternal mortality attends this very serious condition, by whatever method it may be treated.

Mortality.—Out of 10,000 recent consecutive admissions, 119 cases of placenta prævia were treated at Queen Charlotte's Hospital. The maternal mortality in these cases was 10 per cent., but it must be remembered that many of these cases were admitted during labour, after severe bleeding had occurred and various methods of treatment had been applied. The fœtal mortality in the same series, calculated upon the number which died either during delivery or before leaving the Hospital, was 67 per cent. During the same period 129 cases of accidental hæmorrhage occurred with a maternal mortality of 4 per cent. and an infantile mortality of 58 per cent. These figures illustrate very well the greater seriousness of placenta prævia from the point of view of the maternal risks, and also the heavy fœtal mortality which attends both varieties of antepartum hæmorrhage. The fœtal mortality is in part accounted for in both cases by prematurity. In the majority of the fatal cases of placenta prævia the insertion was central. Accidental hæmorrhage is seen to be both more frequent and on the average less serious than placenta prævia. In addition to the maternal *mortality* there is a relatively high rate of puerperal morbidity from septic complications.

Non-expulsion of the Placenta

The natural expulsion of the placenta may be prevented (*a*) by *uterine inertia*, (*b*) by *morbid adhesion* of the placenta or membranes to the uterine wall, (*c*) by the formation of a *contraction ring ;* in all these conditions severe hæmorrhage may occur unless the placental attachments remain undisturbed. If the placenta retains its complete attachments undisturbed there will be little hæmorrhage, for none of the utero-placental vessels have been torn ; when, however,

it is in part but not wholly detached, and the uterus is unable to expel it into the cervix, uterine retraction is impeded and free bleeding occurs from the imperfectly closed mouths of those vessels which have been torn. Though the normal processes of separation and expulsion of the placenta and membranes are always accompanied by hæmorrhage, the amount does not usually exceed 4 to 6 ounces, and is not enough to quicken the pulse-rate or affect the general condition of the mother. Unusually free bleeding at this period (third stage) is always due either to *incomplete detachment* of the placenta or to *laceration* of some part of the genital canal—the cervix, vagina, or vulva. The latter will be considered in the next section in connection with post-partum hæmorrhage.

(1) *Retention of the Placenta. Uterine Inertia.*—In this condition spontaneous delivery of the placenta does not occur, and the after-birth remains in organic union with the wall of the uterus, although its attachments are not abnormal. The cause of the non-detachment of the placenta must be inadequacy of uterine retraction and contraction, for no abnormality can be detected in the placental attachments. Sometimes no hæmorrhage occurs; more frequently a portion of the placenta becomes separated, and then there is hæmorrhage, which may be very profuse, some of the most serious cases of post-partum hæmorrhage being met with before the placenta has been delivered. A practitioner in a hurry may be tempted to diagnose *retention* whenever the placenta is not expelled within a few minutes after the delivery of the child; this is unjustifiable, and at least an hour should be allowed to elapse, unless there is unusual hæmorrhage, before the case is regarded as abnormal. When there is no hæmorrhage the condition is not urgent, and delay can do no harm; if there is much hæmorrhage no delay can, of course, be allowed. If the placenta cannot be expressed (see p. 335) the treatment consists in digital removal of the after-birth from the uterus. In the case under consideration, no difficulty whatever attends the detachment of the placenta by the fingers, showing that there is no structural abnormality. But this operation, though simple and easy, is attended by definite risks, and should never be undertaken merely to save time.

(2) *Morbid Adhesion of the Placenta.*—The pathology of this condition is imperfectly understood. Clinically it is characterised by unusual firmness of the placental attachments, in consequence of which spontaneous delivery is rendered impossible. It is rare for the whole placental site to be thus affected ; usually the change is partial in extent. It is attributed, and with probability, to inflammatory changes in the decidua, resulting in the formation of more or less extensive firm organic connections with the uterine wall. From this view it is easy to proceed to the assumption that some form of decidual endometritis is the original lesion ; and this assumption is supported by the observation that the condition not infrequently recurs in successive pregnancies. But pathological proof has not yet been advanced, because it is difficult to obtain material in a suitable condition for histological examination, inasmuch as the placenta, in these cases, is usually obtained in fragments torn from the uterine wall.

Morbid adhesion of the placenta usually causes severe hæmorrhage in the third stage, but sometimes there is little or none. The amount of bleeding depends mainly upon the extent of the adherent area ; when this is large, only a small part of the placental site can be laid bare—*i.e.* can give rise to hæmorrhage ; when the adherent area is small a large extent of the placental site may be denuded and thus cause severe bleeding.

Simple *retention* and *morbid adhesion* of the placenta can only be distinguished from one another by digital separation of the after-birth. In the former condition this is easy ; in the latter it is difficult owing to the presence of dense fibrous bands which must be torn through, or owing to firm union between the placental and uterine surfaces. The treatment of a morbidly adherent placenta is the same as of a retained placenta—viz. to remove it by intra-uterine manipulation.

(3) *Morbid Adhesion of the Membranes.*—When this occurs, the placenta, though expelled from the uterine cavity, remains suspended in the cervix or vagina by non-separation of the chorion from the uterine wall (Fig. 121), and cannot be delivered by voluntary expulsive efforts or by gentle compression. Abdominal examination shows that the placenta

has left the uterus. If energetic compression of the uterus is practised the placenta may be torn away and expelled with the amnion, leaving a large part of the chorion in the uterus. In point of fact this is what usually occurs in such cases, and the fact that the membranes are morbidly adherent is not recognised until the after-birth has been delivered, when it is found on examination that the chorion is deficient. The amnion is seldom adherent and usually comes away entire with the placenta. If the condition is recognised before the delivery of the placenta, no further attempts to deliver it by compression should be made, but digital detachment should be practised, the fingers being passed up the side of the placenta into the uterus to the site of the adhesion. When it is found that a piece of the chorion has been torn off, a vaginal examination should be made, and if the piece is found hanging down into the vagina it should be carefully removed by twisting it with a pair of forceps. If the end cannot be felt in the vagina, nothing further should be done ; the piece of membrane will become detached and spontaneously expelled during the first week of the puerperium, and if efficient asepsis has been secured, no harm results. The alternative is to explore the uterus by passing the whole hand into it, and this procedure, even when carefully carried out, often results in bacteria being carried from the vulva into the uterus. A high percentage of morbidity from sepsis is found in cases in which the hand has been passed into the uterus during or after the third stage of labour.

(4) *Contraction Ring* (Hour-glass Contraction).—The causation of this condition has been already discussed (p. 450) in connection with its occurrence in earlier stages of labour. In the third stage it causes great narrowing of the lumen of the uterus and prevents the expulsion of the placenta. The upper part of the uterine body, which, though retracted, is lax and contains the placenta, is separated by a ring of spasm from the lower segment and cervix, which are also lax ; hence the name of hour-glass contraction which has been applied to it (Fig. 257). The condition occurs after prolonged or difficult labour, but the administration of ergot before delivery, at one time regarded as the principal cause, has probably little to do with its causation.

A similar condition may occur in the first and second stage of labour, and has been already referred to.

If the placenta becomes partly or wholly separated there will be severe hæmorrhage, for its expulsion through the ring of spasm is impossible ; if not, there will be none. In the former case immediate removal of the placenta is called

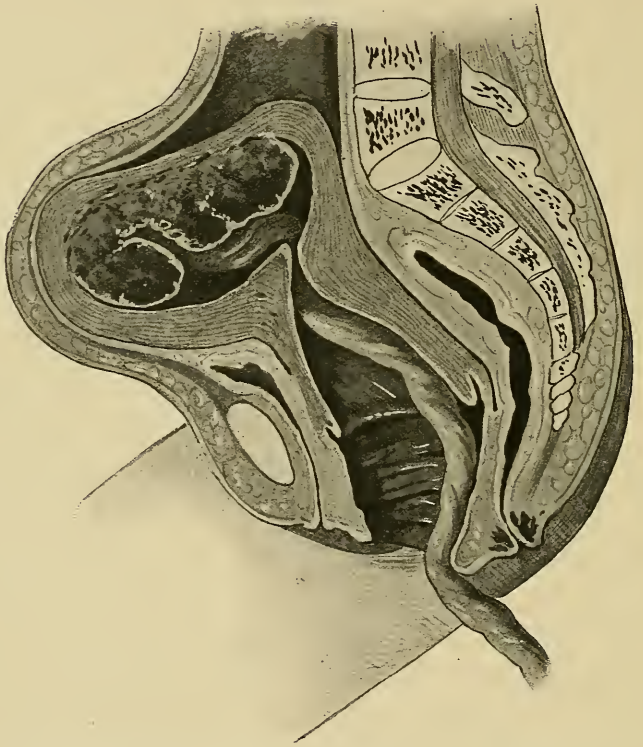


Fig. 257.—Retention of the Placenta due to a Contraction Ring. (After Bumm.)

for ; in the latter, it is best to wait for two or three hours before attempting removal, in order to get rid of the local spasm ; this may be aided by the administration of a full dose of morphia hypodermically ($\frac{1}{2}$ grain). Considerable difficulty may be experienced in dilating the ring of spasm, if the operation has to be undertaken immediately.

Sometimes the presence of a fibroid tumour in the lower

part of the uterine wall will offer the same kind of obstacle to spontaneous expulsion, and the same kind of difficulty in artificial delivery, as irregular retraction.

Digital Removal of the Placenta.—This operation should not be lightly undertaken, for it is by no means devoid of

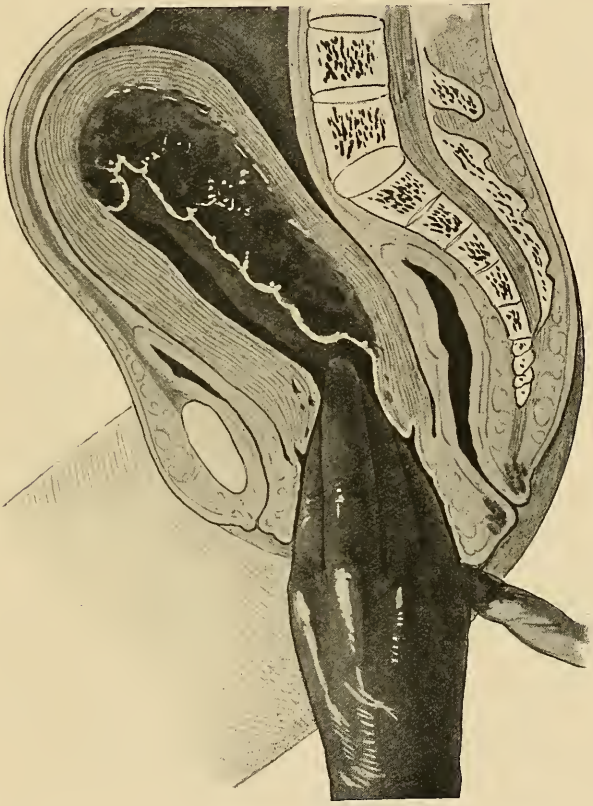


Fig. 258.—Introducing the Hand into the Vagina.

risk. An anæsthetic should be given, and the patient placed in the dorsal position with the legs supported by attendants or a Clover's crutch. The most scrupulous antiseptic precautions must be taken in sterilising the hands and vulva and a pair of previously sterilised rubber gloves should be used in all cases. A hot (118° F.) intra-uterine douche should be prepared for administration at the close of the

operation. Either hand may be passed into the vagina, the other being employed to steady the uterus. The fingers and thumb should be bent into the shape of a cone (Fig. 258), and the whole hand gently introduced through

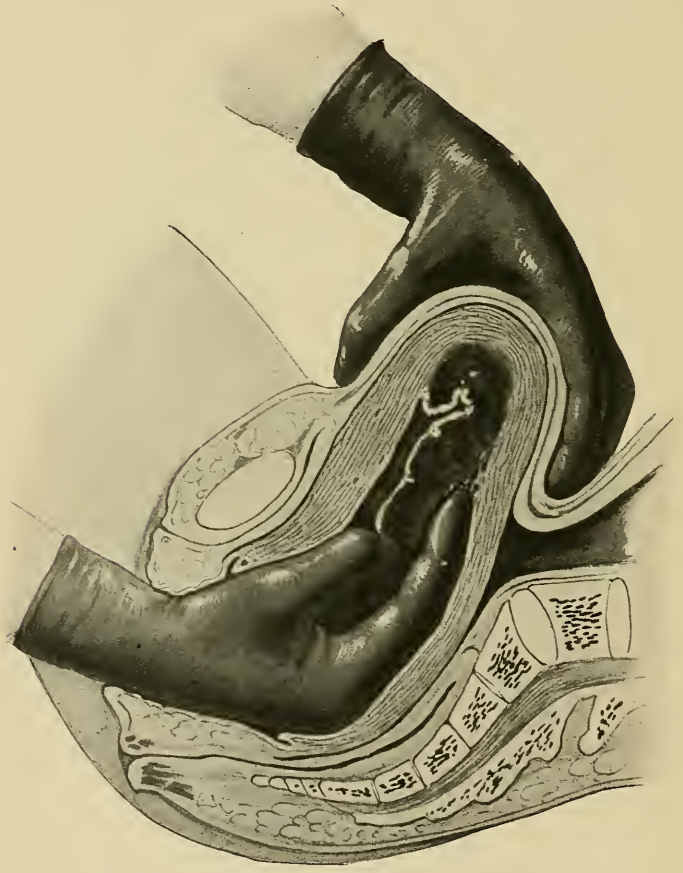


Fig. 259.—Digital Separation of the Placenta.

the vulva, the labia being separated with the fingers of the other hand ; the whole hand may then be passed up *between the membranes and the uterine wall* until the lower placental border is reached. If the fingers are inadvertently passed inside the collapsed amniotic sac, they must be withdrawn and re-introduced outside the membranes.

In a case of simple *retention* it will be found to be perfectly easy to insinuate the fingers under the placental edge, and gradually detach it from the uterus, the fingers sweeping the wall on both sides (Fig. 259). This should be continued until the whole of the placenta has been completely detached; then the mass is grasped in the fingers and gently withdrawn into the vagina, the membranes being peeled off behind it. The fundus is steadied by the other hand grasping it until the operation is finished. It is important fully to detach the placenta before beginning to remove it, otherwise fragments may easily be torn off and left behind. Every effort should, however, be made to detach the whole of the placenta and sweep it out of the uterus before withdrawing the hand, thus avoiding the necessity of introducing it a second time. Immediately after the placenta has been removed it should be examined, and if it or the membranes are incomplete the hand must again be introduced and the retained portions removed. A hot intra-uterine douche should then be administered to stimulate retraction and remove clots, and to counteract the possible effects of the introduction of air or impurities. A dose of ergot should be given, and it is important to make sure that the uterine cavity is completely empty, as described on p. 336. Carelessness in performing this operation may result in perforation of the uterus, incomplete removal of the placenta, or troublesome hæmorrhage; in spite of precautions a mild uterine infection frequently occurs in the puerperium.

When there is *morbid adhesion* of the placenta, difficulties will be encountered. In this case it is best to begin with the detached portion, if this can be found. The finger-tips must be used in clearing the uterine wall, and great gentleness is, of course, called for in all the manipulations. The use of the curette is inadmissible, but blunt ovum forceps (Fig. 235) may be used to seize and detach portions of placenta which cannot be separated by the fingers. Every effort should be made to remove completely the whole of the placenta and chorion, but it is often difficult to make certain that this has been done.

In *irregular retraction* the difficulty consists in dilating the ring of spasm sufficiently to admit the fingers and allow of the removal of the placenta. A full hypodermic dose of

morphia given beforehand assists the anæsthetic in relaxing the spasm. Dilatation should be performed with the fingers alone.

Post-partum Hæmorrhage

Hæmorrhage which occurs after delivery is called post-partum hæmorrhage ; its occurrence is most to be feared immediately, or within an hour or two after labour is over. Hæmorrhage occurring after the first day of the puerperium is called *secondary post-partum hæmorrhage*, or *puerperal hæmorrhage ;* the latter term is preferable, as it is desirable not to confuse it with the form of hæmorrhage under consideration. Many lives have been lost from this complication of labour ; bleeding may supervene so suddenly and profusely that, unless it can be checked, death will ensue within half an hour to an hour. A disaster such as this may follow a rapid and apparently an easy labour ; it is therefore of the first importance that its causation, and the principles which underlie its prophylaxis and immediate treatment, should be clearly understood. In proportion as these principles are generally acted upon, post-partum hæmorrhage becomes less frequent and less formidable.

Causation.—There are only three local conditions which can be regarded as immediate causes of post-partum hæmorrhage—viz. *uterine exhaustion* or *inertia*, *mechanical obstacles to retraction*, and *lacerations* of some part of the genital tract (cervix, vagina, vulva) ; in the two former the bleeding comes from the torn utero-placental vessels (placental site) ; in the latter from torn vessels at the seat of injury. Uterine exhaustion at this period implies failure, more or less complete, of both contraction and retraction—*i.e.* it is identical with the condition previously described as secondary inertia (p. 443). Cases of real gravity which imperil or destroy life are generally due to this cause ; it is obvious that exhaustion of the uterus, when the placenta has been separated, will allow of hæmorrhage of the most profuse kind, for muscular action is the only effectual means of closing the mouths of the torn utero-placental sinuses. The circumstances which may lead directly or indirectly to post-partum uterine inertia must therefore be carefully borne in mind ; they can be

conveniently grouped into *predisposing* and *immediate* causes. As they have all been previously considered in detail, little more than an enumeration of them is here required.

Predisposing Causes of Post-partum Inertia.—Multiparity, especially when associated with rapid child-bearing, is the most important; such cases, in other words, as are liable to secondary inertia during labour. Post-partum hæmorrhage from inertia in a primipara is rare. *Debility*, especially as met with among the poor from insufficient feeding and insanitary occupations or surroundings, is also of importance. *Over-distension* of the uterus (twins, hydramnios), *ante-partum hæmorrhage*, *secondary inertia* during the second stage, *protracted* or *precipitate labour*, and *prolonged anæsthesia* must all be regarded as conditions which increase the risks of the occurrence of post-partum inertia.

Immediate Causes of Post-partum Inertia.—Artificial delivery of the child during a period of *secondary inertia* involves serious risk of post-partum hæmorrhage, as has been already explained in another place. It may be repeated here that absolute cessation of the pains of labour forms a contra-indication to delivery. One of the causes most frequently met with is *mismanagement of the third stage* of labour. The importance of continuous manipulation of the uterus during and after this stage has been pointed out; if this precaution is neglected the uterus may fill with blood and even become distended (relaxed) without any external bleeding attracting attention; serious loss of blood may then occur, which will in turn induce an extreme degree of inertia. The uterus very generally requires stimulation at this period of labour. Sometimes post-partum inertia appears to be reflexly induced by a *full bladder*, and it may also without doubt be brought on by *nervous shock*. It is probable also that in some cases inertia is complicated by *deficient coagulability* of the blood preventing the formation of thrombi in the mouths of the sinuses, but with the exception of some varieties of anæmia and the rare disease hæmophilia, we know nothing of the conditions which cause it. Since efficient retraction of the uterine muscle suffices of itself for the immediate arrest of the hæmorrhage, deficient coagulability of the blood is of secondary importance.

Incomplete Retraction.—Mechanical obstacles to proper

retraction will occur when portions or the whole of the placenta or membranes have been retained in the uterus, and sometimes when there is a fibroid tumour in its wall. It does not necessarily imply want of activity of the uterine muscle.

Lacerations.—Those which affect the cervix and run up into the vaginal roof, so as to open the broad ligament to a greater or less extent, are the most formidable ; arteries of considerable size, and large venous plexuses, may be laid open, giving rise to free bleeding. Tears of the vulva and lower vaginal walls seldom cause severe hæmorrhage ; but it must be remembered that the large artery to the clitoris may be lacerated by a tear of the anterior part of the vulva, or the artery to the bulb by a deep lateral tear of the perineal body.

Diagnosis.—Post-partum hæmorrhage is usually external ; it may, however, be either partly or entirely concealed from distension of the uterus with blood-clot, or from the formation of a large broad-ligament hæmatoma. The condition of the uterus is an important indication of the cause of the bleeding ; for if exhausted it is soft and flabby, with indistinct outlines ; but if the bleeding comes from a laceration the uterus will probably be found to be hard and well retracted. Uterine inertia and lacerations may, of course, exist in company ; it is necessary to remember this when hæmorrhage continues after proper retraction of the uterus has been secured. Careful digital examination will be required to detect deep lacerations involving the vaginal roof.

A. Treatment of Hæmorrhage from Inertia.—In normal labour the separation and expulsion of the placenta are neither accompanied nor followed by serious bleeding because the mouths of the torn maternal vessels are immediately closed by continuous retraction of the uterine muscle, especially of the reticulated layer ; after the lapse of a few hours firm thrombi are formed in the mouths of the torn vessels, which plug them securely. Retraction is at first by far the more important ; for thrombosis alone must be powerless to prevent hæmorrhage from large arteries until time has been allowed for the consolidation of the thrombi. The treatment of post-partum hæmorrhage from inertia must therefore be directed in the main towards restoring the

suspended activity of the uterine muscle, efforts to promote thrombosis being relegated to a strictly secondary position. When stimulation of the uterus is unsuccessful, bleeding can be temporarily arrested by compression of the organ, while time is allowed for the recovery of the functions of the muscle. In severe cases there is no time to lose, and it is of the utmost

Fig. 260.—Expression of the Placenta by Pushing the Contracting Uterus Downwards and Backwards into the Pelvis.

importance that the treatment adopted should be prompt and efficient. The following methods of stimulating the uterus should be employed consecutively, and in the order stated, until success is attained :

(1) *Manipulation of the Uterus per Abdomen.*—At the first sign of unusual hæmorrhage this method can be instantly applied ; it is therefore mentioned first. The uterus should

be seized with both hands, rubbed and squeezed, firmly and continuously, until it is felt to respond by becoming harder as it is manipulated. If the placenta has not been delivered it should at once be expressed, or if necessary removed by introducing the carefully sterilised and gloved hand into the uterus. When fairly contracted the uterus should be firmly squeezed in the hand, and pressed downwards and backwards in order to express all blood-clot from it (Fig. 260). Firm retraction will not be obtained until the uterine cavity has been completely emptied. Even when the bleeding has apparently been controlled in this manner, gentle massage must be kept up for half an hour or more, as relaxation may recur. Difficulty in applying this method may be met with when the hæmorrhage is concealed and the uterus distended and flabby. Such cases are better dealt with in the first instance by *clearing out the uterus*.

(2) *Administration of Ergot.*—A full dose of ergot may be given as soon as abdominal compression is begun. Its effect is produced most rapidly when given by deep intramuscular injection, and the buttock is a convenient spot for the purpose. 1 c.c. of a 20 per cent. solution of pituitary extract or ten to twenty minims of the injectio ergotinæ hypodermica may be given ; these solutions should always be sterilised. If given by the mouth, the dose should be from one to two drachms of the extractum ergotæ liquidum. While very useful in cases of moderate severity, ergot appears to have no effect upon a completely exhausted uterus, and if the condition of the patient is very serious, time should not at this stage be occupied in administering it.

(3) *Hot Douches.*—While abdominal compression is being practised the nurse in attendance can prepare a hot douche (temperature 120° F.) of boiled water, or some mild antiseptic such as lysol (a teaspoonful to a quart). This is a valuable supplement to abdominal manipulation, for it powerfully stimulates the retraction of the uterine muscle. Given through a long tube passed up to the fundus of the uterus, it is of course more effectual than when employed vaginally. The medical attendant cannot leave the uterus when there is serious bleeding in order to prepare the douche, and unless a reliable nurse is present, it had better be omitted at this stage. It is of the greatest service in

increasing and maintaining retraction when the hæmorrhage has been to a great extent controlled by other means, but it is of little use to give it until the uterus has been fairly well emptied of blood-clot by compression or by the method next to be described.

(4) *Clearing out the Uterus.*—When abdominal compression fails to produce an adequate response, when there is concealed bleeding, or when the placenta has not been delivered and cannot be expressed, the uterine cavity should be promptly cleared out with the fingers. The most careful sterilisation of the hands must be practised before this is done and sterilised rubber gloves should be worn. The whole hand can be introduced into the vagina immediately after labour without causing the patient much pain, and two or three fingers can then be passed into the uterus, and, working in connection with the other hand upon the fundus, will readily clear out retained portions of the after-birth or blood-clot and at the same time powerfully excite the uterus to contract. Great care must be taken not to overlook small portions of adherent placenta. When the uterus has been emptied, a hot *intra-uterine* douche can be administered, the nozzle being passed and guided up to the fundus before the hand is withdrawn.

All but the most serious cases of hæmorrhage from inertia can be successfully dealt with by these means. In the worst cases, which are fortunately very rare, these methods may fail, and recourse must then be had to the following modes of treatment :

(5) *Bi-manual Compression of the Uterus.*—This can immediately be carried out if evacuation of the uterine cavity followed by an intra-uterine hot douche fails to induce proper retraction. The whole hand is passed into the vagina, and closed so that the fist lies beneath the uterus ; the other hand is laid palm downwards upon the abdominal wall over the fundus, and the body of the uterus is firmly squeezed between the two hands. In this way the placental site is directly compressed, and bleeding from the utero-placental vessels controlled. It may be necessary to keep up this form of compression for a prolonged period while other measures are adopted for restoring the patient, and so enabling the uterus to recover its activity. This method is

most effectual and has superseded the old-time plan of directly compressing the abdominal aorta against the lumbar vertebræ; pressure applied directly to the site of bleeding is, of course, much more effectual than compression of such a large vessel as the abdominal aorta.

(6) *Plugging the Uterine Cavity with Gauze.* — This may be done as an alternative to the last-named, or after bi-manual compression has been applied without complete success. Long strips of gauze, 2 or 3 inches wide, and tied together, can be stuffed into the uterus, beginning at the fundus and tightly packing the whole organ down to the cervix. In plugging the uterus the cervix should be seized with a strong pair of volsellum forceps, with which it can be easily pulled down to the vulva; the gauze is then introduced directly into the uterus with a long probe or pair of forceps. A very large quantity of gauze is required to fill the uterus. The best material is gauze impregnated with oxychloride of bismuth; this substance is an antiseptic of more potency than iodoform, and the gauze can be left for a longer time in the uterus. Domestic substitutes, such as strips of boiled linen, may be used in an emergency. The uterine plug acts mainly as a powerful excitant of uterine contractions; but it is quite possible to pack the organ so tightly as to control hæmorrhage by direct pressure. When retraction has been excited, a greater amount of direct pressure will also be exerted by it. Bi-manual compression is more useful than plugging, because it can be instantly applied, and requires no assistance or appliances. Plugging is further subject to the disadvantage that complete asepsis is so difficult to maintain when this method is employed. Bi-manual compression is therefore in all circumstances the method of choice.

(7) *Methods of promoting thrombosis* in the uterine vessels were formerly practised, but have now been almost entirely abandoned. The injection of solutions of iron into the uterus, though useful at the moment in arresting bleeding, was frequently followed by sepsis. In adrenalin we now possess a harmless hæmostatic, which can be obtained in sterile solution, and it would be sound treatment to swab the uterine walls thoroughly with this solution (1 in 1,000 to 1 in 2,000), or previously to soak in it the gauze used for packing, in any

case in which complete control of the bleeding could not be obtained by other methods. Also its use would be clearly indicated in subjects of hæmophilia.

Hæmorrhage from *incomplete retraction* should be treated by the immediate removal of what is retained in the uterus, and then by the same measures as in the case of inertia.

B. **Treatment of Hæmorrhage from Lacerations.**—Lacerations of the vulva and lower parts of the vaginal walls causing hæmorrhage should be immediately closed by suture, bleeding points being first ligatured. Deep lacerations of the cervix and vaginal roof are not easily closed by sutures, although with two pairs of strong forceps on the cervix the uterus can be drawn down a great deal; it may be very difficult to reach the highest point of the tear, and if the broad ligament has been opened bleeding points may be quite inaccessible. Accordingly many cases have been recorded where bleeding has continued after the laceration has been apparently sewn up. Two alternative methods to suture may be adopted: (1) Bi-manual compression; (2) plugging with gauze. *Bi-manual compression* is described and practised by Fritsch. He places the closed fist against the perineum and presses the pelvic floor deeply into the pelvic outlet; owing to the relaxed and insensitive condition of the parts this can easily be done. The uterus at the same time is pressed firmly downwards from the abdomen with the other hand, and thus the parts in the vicinity of the vaginal roof can be effectually compressed between the two hands, and the bleeding controlled. For *plugging* a laceration in the vaginal roof a speculum and a good light are required, and this method may therefore be very difficult to apply in domestic practice, although valuable in lying-in hospitals.

C. **Restorative Treatment.**—Although the first indication in treatment is to arrest the bleeding, the general condition of the patient, in severe cases, also requires prompt attention, lest death from syncope should occur after the hæmorrhage has been controlled. While preparations are being made for the restorative measures described below, first aid in a serious case of hæmorrhage can be given by lowering the head and holding up the arms and legs in a vertical position, and if bandages are at hand, by bandaging the limbs from

the feet or hands towards the trunk. In this way blood is conserved in the vital parts of the body. The best method of immediately counteracting the effects of severe loss of blood is the administration of normal saline solution in large quantities. Even when the patient's condition is not urgent, the injection of a pint or a pint and a half of this solution into the rectum is the best means of counteracting the shock and relieving the thirst which always follow severe hæmorrhage. But if, during or after the bleeding, the patient is blanched, cold, unconscious, or if her pulse is over 140, transfusion of 2 pints of normal saline solution into the median basilic vein should be practised. There is no necessity to describe this simple surgical procedure or the apparatus required for its performance. If the necessary apparatus is not at hand, a useful alternative is to inject the solution under strict antiseptic precautions into the subcutaneous tissues with a cannula, a piece of rubber tubing, and a funnel. The skin may be efficiently sterilised by painting it freely with tincture of iodine. A simple apparatus for transfusion occupies very little space in the obstetric bag and should be taken to every case as a routine item of the armamentarium. The most suitable positions for the subcutaneous injection are (1) under the mammary glands, (2) under the skin of the posterior axillary wall, (3) under the skin of the abdominal walls. Salt should be dissolved in water in the proportion of about one teaspoonful to a pint, and the solution boiled for ten minutes and then cooled. If there is no time for preparation, the salt may be simply dissolved in warm previously boiled water. In the absence of the necessary apparatus for transfusion, the saline should be injected into the rectum; not more than one pint and a half can be given at a time, and the solution should be slowly introduced, preferably through a tube and funnel, or the bowel will reject it.

The administration of cardiac stimulants by the mouth and by hypodermic injection is also of great importance, and the obstetric bag should always contain remedies of this kind. Strychnine sulphate, in doses of $\frac{1}{30}$ to $\frac{1}{60}$ of a grain, is a useful remedy for hypodermic medication. Ether or brandy may also be administered in the same manner in doses of 20 to 30 minims. As the researches of Blair Bell have shown, the hypodermic injection of an organic extract

of the pituitary gland is the most powerful means we possess of temporarily raising blood pressure. It may be given in doses of 1 c.c. of a 20 per cent. solution. Elevating the foot of the bed for 10 to 12 inches may also assist the enfeebled circulation. The value of small doses of morphia in controlling restlessness after severe hæmorrhage should not be overlooked ; a dose of $\frac{1}{8}$ to $\frac{1}{6}$ of a grain, alone or in combination with atropine, will relieve pain or restlessness, and often induce a little sleep, which will be of great benefit to the patient.

Labour complicated by Eclampsia

The pathology of eclampsia having been already discussed (p. 113), only clinical points will be here considered.

Occurrence.—When the albuminuria of pregnancy is appropriately treated it seldom terminates in eclampsia. This disease most frequently occurs in women who up to the time of its onset have been in apparently good health ; but had examination of the urine been made, it is highly probable that albumen would in the majority of cases have been found before the onset of the disease. A certain number of cases of eclampsia have been recorded in which no albumen was found in the urine. This is, however, very rare ; Olshausen met with it only once in 168 cases. About 98 per cent. of cases occur after the sixth month (twenty-fourth week), but it has been observed as early as sixteen to eighteen weeks, and a number of instances have been recorded in which it has occurred with a vesicular mole, no fœtus being present at all. The convulsions commence most frequently before, or almost simultaneously with, the onset of labour ; more rarely after labour has been for some hours in progress ; and least commonly after labour is over. Pinard estimates the first-named at 54 per cent., the second at 30 per cent., the third at 16 per cent. of all cases. In true *puerperal* cases the onset of the convulsions is very rarely delayed for more than forty-eight hours after labour, although in some cases several days have intervened. Labour complicated by eclampsia is usually premature. If there is a history of eclampsia in a previous labour, the presence of chronic nephritis must be suspected.

Clinical Features.—Although eclampsia may attack a pregnant woman who has apparently been in good health up to the moment of its onset, a series of well-marked symptoms sometimes precedes its occurrence. The symptoms associated with the albuminuria of pregnancy may have been present for some time ; but in addition certain other symptoms often occur which constitute what is called the *pre-eclamptic state.* They are (1) severe headache, usually frontal, but sometimes occipital ; (2) functional disturbances of vision, such as muscæ volitantes, diplopia, hemianopsia, and temporary amblyopia ; (3) occasionally well-marked albuminuric retinitis, with considerable failure of vision ; (4) puffiness of the eyelids and cheeks ; (5) severe epigastric pain, with giddiness, nausea, or vomiting ; (6) occasionally, attacks of *petit mal.* The condition of the urine seldom furnishes premonitory signs, but a sudden diminution in the total amount of the urinary secretion may occur, and must be regarded as of great significance. In addition, the amount of albumen may rise, the amount of urea may fall, and the proportion of ammonia nitrogen consequently become increased (see p. 109). Clinical observations indicate that a definite rise in blood-pressure precedes the occurrence of fits. This point has, however, not been completely established, but during the stage of convulsions blood pressure is invariably raised.

The convulsions are epileptiform in character, and consist of a stage of tonic, followed by a stage of clonic, contractions. Each convulsion is ushered in by fibrillary twitchings in the muscles of the face, tongue, and limbs, often followed by conjugate deviation of the head and eyes—usually to the left side. Then comes a brief period of tonic contraction in which respiration ceases, and the trunk may pass into the condition of opisthotonos ; this is accompanied by marked cyanosis, the face being livid, and the tongue protruded between the teeth. This stage usually lasts less than half a minute, and gives place to general clonic contractions which appear to affect all the voluntary muscles of the body. Slight respiratory movements now occur, and the cyanosis gradually passes off during the period of three to five minutes which this stage generally occupies. A varying amount of mental disturbance follows the fit : in some cases

the patient appears to be merely sleepy or somewhat dazed for a few minutes; in some cases there is a brief period of coma; in others deep coma persists, the patient failing to regain consciousness before the onset of the next convulsion.

The convulsions are almost always multiple; they may occur every hour, or every half-hour; in more serious cases, with greater frequency than this. As many as a hundred fits may occur in a single case. During the eclamptic state the excretion of urine is greatly diminished, and may for some hours be suppressed; it frequently contains blood, and nearly always a large amount of albumen, becoming solid on boiling. Suppression of urine is probably induced secondarily by spasm of the renal arterioles, which diminishes the amount of blood circulating through the tissues of the kidney. In all cases of eclampsia the urine must be examined, the catheter being employed to obtain a specimen if necessary. A high blood pressure is always present in fully developed eclampsia, and readings of over 200 mm. are often met with. This rise is generally believed to be due to general arterial spasm. When a considerable number of fits has occurred, the temperature usually rises to 101° to 102° F., and in some cases there is hyperpyrexia. Death may result from coma, from cerebral hæmorrhage, or from pulmonary œdema.

Diagnosis.—It is necessary to distinguish the following conditions from eclampsia: (1) epilepsy; (2) hysteria and hystero-epilepsy; (3) convulsions or coma due to cerebral disease, diabetes, or acute poisoning. *Uræmic convulsions* are difficult to distinguish from eclampsia, but the general line of treatment to be pursued is much the same in both. Cases of *epilepsy* can usually be recognised by the history obtained from the patient or her friends; when a history cannot be obtained, the condition of the urine furnishes the most reliable means of distinction; but it must be recollected that in the rare cases of eclampsia without albuminuria the absence of albumen from the urine will be misleading. In general clinical features, the *status epilepticus* closely resembles a severe case of eclamptic coma with elevation of temperature. Cases of *hysterical* fits, and cases of *coma* due to causes other than renal, must be differentiated

by attention to the special features of these disorders into which we cannot enter here.

Prognosis.—The outlook in eclampsia is always very serious both for mother and child. The *maternal mortality* appears to vary considerably with the severity of the cases and the method of treatment employed ; percentages are of little value unless given in relation to the same line of treatment. The mortality is decidedly higher in multiparæ than in primiparæ. The greater the number of fits, the more serious is the prognosis ; in cases where more than twenty seizures occur it is said that the mortality is upwards of 50 per cent. When the fits are prolonged, when the temperature steadily rises, and when there is early or continuous coma the prognosis is very grave indeed. Extreme degrees of anuria which do not yield to treatment are always of the gravest significance. Jaundice is rarely met with, but is sometimes present, accompanied by scanty and bloody urine ; a fatal termination must then be expected. Yet the great majority of mild cases of eclampsia recover, labour terminating speedily, and the number of convulsions not being great. In severe cases which recover, prolonged mental disturbance may continue, or insanity may supervene in the puerperium.

The *fœtal mortality* is largely influenced by the period of gestation ; in cases at the twenty-eighth week or earlier it amounts to nearly 100 per cent., becoming less as term is approached. Under the most favourable conditions it is probably as high as 40 to 50 per cent. The occurrence of convulsions in the new-born child, and of post-mortem hepatic lesions similar to those of the mother, has been already mentioned. This heavy mortality is to be attributed to prematurity and debility, to intra-uterine intoxication, to placental disease, and to the effects of operative interference.

Treatment.—Severe cases tax the resources of treatment to an extent unequalled in obstetric complications. Only in the earliest stages can the disease be controlled with any certainty. It is, therefore, most important that the significance of the symptoms of the *pre-eclamptic stage* should be clearly understood, for at this moment prompt treatment may avert the convulsions. When once the convulsions have

begun, the patient should be sent immediately to the hospital if there is one within reach, or in cases of the better class arrangements should be made for continuous medical and nursing supervision of the best and most experienced kind which may be available. If only a single convulsion has occurred, there are possibilities of the gravest developments, and no precautions must be neglected. A specimen of urine should be obtained immediately, and complete examination made, including, if possible, the tests for acetone and diacetic acid, estimation of the amount of albumen, and a microscopic examination of the centrifugalised deposit.

General Principles.—Cases of eclampsia vary so greatly in severity that no routine can be followed in treating them. The general principles upon which treatment should be based are accordingly of uncommon importance, and must be carefully considered. These principles are based upon the view that eclampsia is a complex toxæmia, the original source of which is the placenta; further, secondary sources of toxæmia arise during the course of the disease from profound alterations in metabolism (liver, endocrinous glands), and from failure of the excretory functions of the kidneys. It is not possible by cutting off the original source of the toxæmia, *i.e.*, by emptying the uterus, to cure the disease in every case, for a lethal dose of toxins may be already present in the body; or, again, the structural damage sustained by important viscera, such as the liver, may be so great that these organs may fail to recover their functional activity, so that the existing toxæmia is intensified and death ensues. Nevertheless, the disease cannot be finally cured until pregnancy has been ended.

There are accordingly two immediate objects of treatment: (*a*) to terminate the pregnancy; (*b*) to promote the elimination of the toxins, and to neutralise their effects. The relative importance attached by different schools to these two objects of treatment is not the same. An important school regards the first as all-important, and is, therefore, prepared to subordinate everything to a rapid emptying of the uterus. To this school the treatment of eclampsia is mainly a *surgical* problem. Another equally important school regards the second object as all-important; the

termination of labour is a secondary matter, eliminative treatment is of prime importance, and accordingly to these the treatment of eclampsia is mainly a *medical* problem.

The surgical school encounters two practical difficulties. Firstly, the subjects of profound toxæmia are extremely sensitive to the effects of surgical shock, and in many cases the uterus can be rapidly emptied only by the performance of a serious operation. Secondly, the toxæmic symptoms are not in all cases relieved by the termination of pregnancy; this will be understood from what has been already said about the secondary sources of toxæmia. Herman has shown that in 57 per cent. of cases fits continue after labour. And, again, in 1·6 per cent. of cases the convulsions do not begin until labour is over. Consequently the patient may survive the operation of delivery and yet die of the disease. These objections are met by the surgical school with the plea that if an early resort to operation could always be made, *i.e.*, before the toxæmia had become profound, these difficulties would be largely avoided.

The medical school also encounters two difficulties. Firstly, the effect of medical treatment is uncertain, and the worst cases do not respond to it at all. This failure involves a loss of time which seriously prejudices the success of a subsequent operation, for the toxæmia is deepening all the time. Secondly, under the most favourable conditions this treatment is palliative, not curative, and unless the uterus is emptied, the source of the specific toxins will not be cut off. Operative measures may therefore be required as well.

One of the chief practical difficulties in the treatment of eclampsia is that the worst cases usually set in with unexampled suddenness and severity. If an early stage of mild toxæmia were always apparent, success by either method would be much easier to attain. In point of fact, the less severe cases may be successfully managed by either the surgical or the medical plan; the worst cases are attended by a heavy mortality whatever treatment is adopted.

We may now consider in more detail the medical and surgical measures which may be adopted in treating cases of eclampsia.

A. Medical Treatment.—The immediate objects of this treatment are (*a*) to promote elimination; (*b*) to neutralise, if possible, the effects of the toxins. The first object is much easier to attain than the second. At the same time labour is induced or its progress expedited by methods which involve the least possible shock.

Eliminative Treatment.—The aim of eliminative treatment is to promote by all possible means the elimination of toxic bodies from the blood and from the tissues. The methods which may be employed are :

(*a*) *Venesection.*—From 10 to 15 ounces of blood may be withdrawn from the median basilic vein or some other source ; this obviously at once reduces the total amount of poison in the blood. At the same time it reduces blood tension, which is always high in toxæmia. Lichtenstein has recently attempted to show that the apparent benefit following operative delivery in eclampsia is in reality due to the loss of blood which accompanies it. It is only suitable for ' sthenic ' cases ; when wasting has occurred or when marked anæmia and anasarca are present it is contra-indicated.

(*b*) *Saline Transfusion.*—This is best carried out by the *direct* method, which consists in introducing from one to three pints of sterile saline solution through a cannula into a vein. It may conveniently be combined with venesection, the same vein being made use of for both purposes. The immediate effect is to reduce the concentration of the toxins in the blood serum and thus to diminish their activity. In eclampsia a slightly alkaline solution should be used in order to neutralise the excess of acid bodies which are present in that condition. For this purpose 30 grains of acetate of soda may be added to each pint of normal saline, as recommended by Jardine. Other more remote effects are that diuresis and, to a less extent, diaphoresis are produced ; in other words, a direct eliminative effect is seen, but this may not appear for twenty-four hours or more after the administration.

Other methods of introducing saline solution into the circulation may be employed, however, viz. subcutaneous transfusion, or saline enemata. Absorption of fluid from the subcutaneous tissue is rapid, and also from the rectum

when empty ; but neither achieves such rapid results as the intravenous method.

Subcutaneous transfusion is carried out with simple apparatus consisting of a trochar and cannula, a funnel and tube. A Southey's tube serves the purpose admirably, and can be introduced without causing pain. The floor of the axilla, the submammary region, and Scarpa's triangle are convenient positions for it. Strict antiseptic precautions must be observed, the apparatus being boiled, and the skin painted with tincture of iodine ; even then there is a certain risk that skin organisms may be carried into the cellular tissue, resulting in suppuration, and sometimes in sloughing. Not more than half a pint should be introduced in one situation, and for this amount to enter at least a quarter of an hour is required. The fluid should be distributed by pressure with the fingers, and undue tension avoided by employing only a low pressure.

Saline *enemata* are rapidly absorbed if the lower bowel is empty ; but large quantities will not be retained, and not more than a pint can be introduced at a time. If the enema is repeated several times the bowel becomes intolerant, and rejects the whole or a part of it. A continuous drop enema (proctoclysis) may be used, but the apparatus is difficult to manage when convulsions occur.

(*c*) *Diaphoretic Measures.*—Free action of the skin is of great importance in aiding elimination and reducing blood-pressure. The hot blanket pack or the electric heat bath are perhaps the quickest and best methods of producing sweating, and should be preferred to any others. Medicinal means are less certain, and have the disadvantage of also causing considerable depression of the circulation. Pilocarpin in doses of gr. $\frac{1}{100}$ by hypodermic injection usually causes profuse perspiration, but it greatly weakens the action of the heart, and for that reason cannot be administered in serious cases. Antipyretic drugs such as phenacetin, antipyrin, and salicylic acid are not to be recommended.

(*d*) *Treatment of the Alimentary Canal.*—It has been already stated that there is reason to believe that toxins are freely excreted by the mucous membranes of the stomach and intestine and may be reabsorbed by the colon. The

contents of the alimentary canal are therefore to be eliminated as far as possible.

The treatment may be begun by stomach lavage; when the contents have all been washed away a full dose of magnesium sulphate in solution may be left in the stomach. Gastric digestion appears to be entirely in abeyance in severe cases, and nothing but water should be given until the patient's condition shows signs of improvement. Hastings Tweedy has insisted upon this point, and has shown the excellent results of the complete withholding of food during the convulsive period of the disease.

Purgation has been employed empirically in eclampsia for many years. Saline aperients such as magnesium sulphate, which act chiefly by stimulating the intestinal secretions, are the most useful. Purgatives should not be administered to a comatose patient, for swallowing is then very imperfect, and anything given by the mouth may pass in part into the air-passages. Purging however is not sufficient. Absorption from the intestine takes place chiefly in the colon, and this part of the bowel must accordingly be kept clear by frequent irrigation. Normal saline, or the alkaline saline solution mentioned above, should be used in large quantities (two to three pints), a long rubber tube being passed for ten to twelve inches into the bowel. The colon irrigation should be repeated until the large bowel is clear of fæcal matter.

(*e*) *Decapsulation of the Kidneys.*—This operation has been advised by Edebohls in severe cases of eclampsia accompanied by anuria, the object being to restore renal activity by relieving the renal circulation by allowing venous oozing from the torn capsular vessels. The operation consists in exposing each kidney in the loin and, after delivering it through the wound, stripping its fibrous capsule partially or completely away. Experimental observations have been made by Ehrenfest on dogs and other animals; he failed to produce diuresis in healthy animals by decapsulation, and in some of his experiments suppression of urine was observed. The scientific basis of the operation is therefore questionable, and the results of the small number of cases in which it has been performed are inconclusive. Advocates of the operation advise that it should not be performed

unless there is extreme anuria, and not until it is clear that evacuation of the uterus has failed to relieve it. Severe cases of post-partum eclampsia which do not yield to palliative treatment have furnished most of the opportunities for this operation.

The importance of restoring the renal functions in eclampsia is obvious and can hardly be over-stated; after the uterus has been emptied it is the chief concern in treatment. Although a surgical measure it is therefore most appropriate to consider decapsulation as an adjunct to eliminative treatment.

Treatment of the Toxic Symptoms.—It is of the greatest importance that the patient should be isolated and all avoidable sources of external irritation—auditory, visual, and sensory—rigidly excluded. There is no doubt that the onset of a convulsion may be precipitated reflexly by any of the ordinary channels of sensation.

During the fit nothing can be done except to prevent the patient from injuring herself. She should be turned upon her side to allow the salivary secretions, produced in excess during the convulsions, to escape from the mouth, and to prevent their finding their way into the air-passages while the patient is unconscious and her reflexes are suspended. To save the tongue from being bitten the best plan is to fold a handkerchief in several thicknesses, pass it between the teeth over the tongue, and hold it in position until the clonic contractions have ceased; or a wooden plug or a spoon handle covered with a handkerchief may be kept between the teeth. The clothing should be arranged so as not to impede respiration.

The main object of treatment will be to *control* as far as possible the *recurrence* of the *convulsions* by the administration of *anæsthetic* or *sedative drugs which directly influence the central nervous system.*

Anæsthetic or *sedative drugs* tend to prevent the periodic explosions of central nerve energy which cause the convulsions. Of all the drugs of this class which we possess, morphia is the most useful in eclampsia, for the reasons that its effect is produced with great rapidity, and that it can be administered by hypodermic injection when the patient is unable to swallow. Half a grain may be given to begin

with, and thereafter doses of a quarter of a grain every two or three hours until two grains have been given in all. Next to this the most generally useful drug is *chloral hydrate*, alone or in combination with *bromide of potassium*. Thirty grains of chloral and fifteen grains of bromide may be given by the mouth every hour, until four doses have been administered ; or they may be given by the rectum, when the dose should be doubled, and the lower bowel must be cleared out before its administration is begun.

These sedatives must be used with discretion, and not applied as routine treatment to all cases. They are chiefly useful in mild cases—*i.e.* those in which the patient recovers consciousness more or less completely between the seizures. In severe cases accompanied by deep and continuous coma, little benefit is to be anticipated from them.

Treatment with morphia and chloral has been extensively practised by Stroganoff, who makes these drugs the basis of the method known by his name. He advises that treatment should be begun with a quarter of a grain of morphia hypodermically, followed one hour later by 30 grains of chloral by the mouth ; two hours later the morphia is repeated, and the chloral repeated six hours after the first dose ; in all four doses of chloral and two of morphia may be given in twenty-four hours. As soon as the convulsions cease and the conditions are favourable labour is induced. Stroganoff's own results by this method have been very good; and Nagel has recently reported a series of 650 cases treated thus with a maternal mortality of only 8 per cent. Such favourable results have not been obtained by the majority of workers with this method.

In France the use of morphia is discountenanced on the grounds that this drug tends to diminish the urinary and other secretions, and that it adds another form of poisoning to those already in existence. These objections are mainly theoretical ; there can be no doubt that morphia in many cases notably diminishes both the frequency and the severity of the convulsions, and this is an important advantage, for by inducing exhaustion convulsions may be the direct cause of death. Its effect upon respiration must be carefully watched, for breathing may become dangerously slow.

Another method much employed is the administration of chloroform; this has been recommended, with certain precautions, in previous editions of this book. Recent advances in our knowledge of the nature of the eclamptic toxæmia have, however, shown that it has certain features in common with chloroform poisoning, viz. the presence of acetonæmia and disorganisation of the liver. The induction of anæsthesia by chloroform in persons not suffering from toxæmia sometimes leads to symptoms of grave poisoning from one to three days afterwards, even in cases where the amount administered has not been large. Chloroform must, therefore, be regarded as a dangerous anæsthetic in eclampsia; its use should be avoided for operative purposes, and it is not advisable to administer it even to produce a light degree of anæsthesia for the control of convulsions. The only general anæsthetic used should be ether.

Treatment of Pyrexia.—Antipyretic drugs should be avoided. If the hot pack previously mentioned fails the body should be rubbed with pieces of ice.

The Circulation.—The outstanding features of the circulation are the rapid pulse, the high tension, and the enfeebled cardiac action. Venesection brings relief to the high tension; intra-venous transfusion probably exaggerates it; but the general good effects of the latter outweigh this disadvantage. In the United States *veratrum viride* has been much employed as a means of reducing the pulse rate and lowering tension, and with apparent benefit. Other writers believe that this effect is accompanied by a depressing action on the heart muscle which is dangerous. In reality we have no reliable means of directly assisting the circulation in eclampsia.

The Conduct of Labour.—While medical treatment is being carried out no obstetric interference is practised except what may be required to assist the course of a labour already in progress. In the majority of cases of a mild type the fits do not begin until a few hours after labour has begun, and its progress is rapid and easy, since the child is often premature and uterine action is powerful. The confinement may then be managed on general principles except in regard to two points: (*a*) the second stage should be terminated by forceps as soon as the head has passed

into the pelvic cavity, ether being used as the anæsthetic for the reasons mentioned above; (*b*) bleeding during the delivery of the placenta may be encouraged, if venesection has not already been practised. If labour has not begun one of the slow methods of induction should be practised (p. 658). In cases of post-partum eclampsia it is obvious that medical treatment alone is applicable.

We may consequently now indicate two types of cases of eclampsia which can be suitably treated by medical methods, viz., mild cases in which labour is in progress, and all post-partum cases. Mild cases occurring before the onset of labour are less favourable, owing to the uncertainty of methods of induction.

A difficult question which has often to be decided is how long to persist in palliative treatment when the results achieved are negative or inconsiderable. Less than twelve hours does not allow sufficient time for definite effects to appear, and the treatment should be carried out thoroughly and continuously for that time. After twelve hours the condition of the patient and of the uterus must decide the question of continuing. If labour has not begun, or is in an early stage, and the toxæmia shows no signs of lessening, surgical treatment should not be postponed, unless it is definitely decided to reject it entirely.

B. Surgical Treatment.—The surgical treatment of eclampsia consists in effecting rapid delivery when labour has not begun, or has only reached the early part of the first stage. There are two methods of rapid delivery which may be made use of. One consists in forcibly dilating the cervix and lower uterine segment until it is large enough to allow the child to be extracted *per vaginam;* it is generally known as *accouchement forcé*, and may be carried out in several different ways, which will be described in the section on 'Obstetric Operations.' The other consists in extracting the child through an incision in the uterine wall (Cæsarean section); it may be done either *per abdomen*, by an intra-peritoneal operation, or *per vaginam*, when the operation is extra-peritoneal.

All these procedures are major surgical operations, not to be lightly performed upon patients suffering from pro found toxæmia. Even when carried out under some form

of local anæsthesia, they produce a degree of surgical shock which, in consideration of the patient's condition, appreciably increases the risk of a fatal issue. Nevertheless in severe cases the results of eliminative treatment are uncertain, and rapid evacuation of the uterus is the only alternative method of dealing with them. The indication for these operations is to save the mother; therefore the condition of the child, whether alive or dead, is unimportant.

Delivery by *accouchement forcé* is the most severe of all, and it is not to be recommended. The amount of shock produced by rapid dilatation of the cervix, by the digital method, for example (see p. 668), is little less than that which accompanies Cæsarean section, and in addition dangerous lacerations of the cervix and vagina are often caused by these operations. Cæsarean section by the abdominal route is the simplest and most expeditious method we possess of rapidly evacuating the uterus, and if operative treatment is decided upon, this is the operation of choice for eclampsia. Cæsarean section of the full time uterus by the vaginal route requires special instruments and considerably more technical skill and experience for its performance, and is therefore only suitable for hospital practice. By the abdominal route the operation can be performed by anyone with a little experience of abdominal surgery.

If possible, operations in eclampsia should be performed under spinal anæsthesia, or some form of local infiltration anæsthesia. If facilities for these methods are not available, ether given by the open method is the best alternative.

Cæsarean section has now been performed fairly often in eclampsia. Writing in 1911, Peterson collated 530 cases, and there is no doubt that this operation is being resorted to with increasing frequency. The operative risk no doubt largely depends upon the duration of the disease at the time of operation; the earlier it is performed the more likely is the patient to recover. Thus Winter has reported fifty-six early cases, some vaginal, others abdominal, with only three deaths.

Choice of Methods.—Four types of cases of eclampsia may be defined :—

(1) A mild case of ante-partum eclampsia is suitable for

medical treatment. At the same time means should be adopted to start labour if it has not begun, or to hasten it if it is already in progress ; the methods of choice are, hydrostatic dilators for induction or during the first stage, forceps during the second stage.

(2) A severe case of ante-partum eclampsia *in which labour is in progress* may be treated by medical means for twelve hours, eliminative treatment being carried out fully. In the absence of definite improvement, labour must then be terminated. If the first stage has advanced, dilatation of the cervix may be completed by the digital method under ether and forceps employed. If the first stage has made little progress, Cæsarean section should be preferred. Up to the thirtieth week the vaginal operation may be performed, as it is then comparatively easy. In the absence of facilities for performing this operation, reliance upon medical treatment alone gives the patient a better chance than *accouchement forcé.*

(3) Post-partum eclampsia must be treated by medical means alone. Renal decapsulation is not advised.

(4) A fourth type remains, which is the most serious of all, viz., that in which severe toxæmia, accompanied by convulsions or coma, or it may be by both, comes on *before labour has begun.* Such cases often occur with dramatic suddenness in women apparently in good health. They do not respond well to eliminative treatment, and loss of time prejudices the chances of a favourable result from surgical interference. They are therefore best treated by Cæsarean section without delay.

A 'severe case' may be defined for practical purposes as one in which any or all of the following conditions are present : (1) frequently recurring convulsions ; (2) drowsiness, stupor, or coma between the convulsions ; (3) suppression of urine ; (4) pyrexia.

Part V

THE PUERPERIUM

The Normal Puerperium

The puerperium is the period succeeding labour, during which certain processes take place, the effect of which is to restore the genital organs approximately to the condition which obtained before pregnancy. The features characteristic of nulliparity are never completely regained, for certain of the changes occurring in pregnancy, and the injuries received in labour, induce alterations which are permanent, although they may vary greatly in degree in different cases. The duration of the puerperal period may be stated as from six to eight weeks, but it is frequently longer than this. We do not possess any absolute clinical indication of the completion of the puerperal changes, but, as we shall presently see, the size of the uterus is the best guide.

Consideration of the normal puerperium comprises the following subjects :

(I.) The general physiology of the puerperium.

(II.) The involution of the genital organs.

(III.) The management of the puerperium, including the process of lactation.

I. **The General Physiology of the Puerperium.**—At the close of a normal labour the *general condition* of the patient is merely that of physical fatigue. The pulse is full and moderately slow—70 to 80 beats per minute ; the temperature is usually sub-normal. Not infrequently a slight shivering, marked by muscular tremor and chattering of the teeth, occurs, and may last from ten to fifteen minutes ; it is unaccompanied by elevation of temperature or pulse-rate, and is to be regarded as a symptom of slight surgical shock. Immediately after a prolonged labour the patient may show signs of well-marked 'obstetric exhaustion,' with

a temperature of 101° F. or higher; and when severe hæmorrhage has occurred there will, of course, be shock and pallor, with a rapid pulse and a lowered temperature.

During the first twenty-four hours the temperature very commonly rises one or two degrees, even after a normal labour, and 100° to 101° F. may in this way be recorded without any unfavourable accompaniments. This is especially common in primiparæ. The rise of temperature is to be regarded as due to the *reaction* from the severe muscular

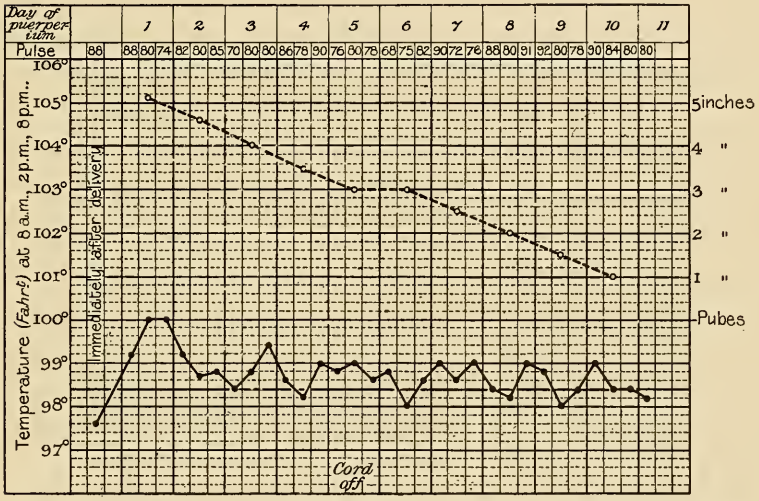


FIG. 261.—Chart of a Normal Puerperium, showing Reactionary Rise of Temperature of the First Day. (Queen Charlotte's Hospital.)

NOTE.—The interrupted line indicates the height of the fundus above the upper border of the symphysis pubis.

fatigue induced by labour; it is never prolonged, and disappears entirely by the second day (Fig. 261). After the first twenty-four hours the temperature shows a diurnal variation of about a half to one degree, and in normal cases it often does not rise above 99·4° F. In many cases, however, which otherwise run a normal course, the evening temperature for the first few days may reach 99·8° or 100° F. Instability of the body temperature is one of the characteristics of the puerperium; consequently variations occur from causes too trivial to produce any effect in health. The temperature should be taken at least three times daily,

convenient hours being 8 A.M., 2 P.M., 8 P.M. ; if taken only morning and evening, an evanescent rise may escape notice. Temporary elevation of the temperature to 100° to 102° F. may occur during the first puerperal week from a number of slight causes, such as errors in diet, gastro-intestinal disturbances, excitement or other nervous disturbance, or mammary discomfort at the commencement of lactation (Fig. 262). It appears certain that gastro-intestinal disturbances are responsible for many cases of slight fever during the first week. Hospital patients admitted when

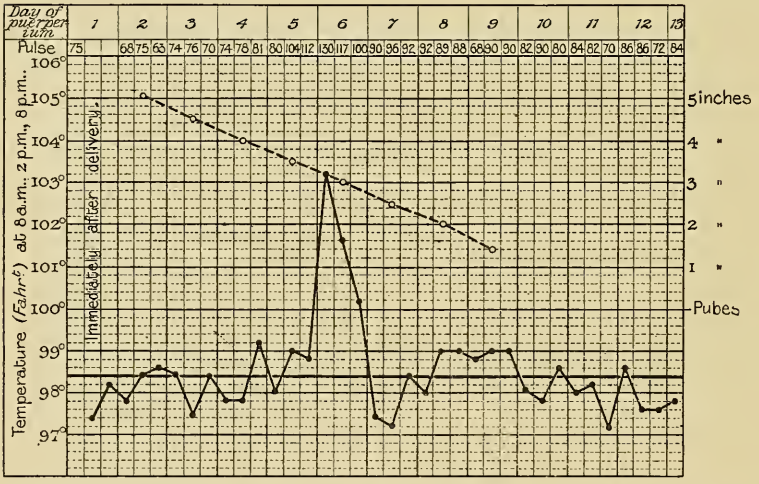


FIG. 262.—The Evanescent Rise of Temperature on the Sixth Day was due to Nervous Excitement. (Queen Charlotte's Hospital.)

labour has advanced too far to allow time for the usual preparation by an aperient naturally show this form of pyrexia more often than others who have been properly prepared. In many other cases the administration of a purgative is immediately successful in bringing down the temperature, although no other treatment is adopted. Fever from excitement is the most evanescent of all, and lasts only a few hours. The fourth day is the time when the breasts become most severely distended, and rise of temperature from this cause may be met with. Primiparæ are the more liable to it, but when suitably treated the fever seldom lasts more than twenty-four hours. Pyrexia from any of

these causes does not in any way disturb the general course of the puerperium.

The significance of a rise of temperature in the puerperium is accordingly often obscure at first. Fever lasting for twenty-four hours or more is a certain indication of 'morbidity,' but evanescent rises of temperature are not necessarily to be regarded as definite evidences of abnormal developments. Various standards of 'morbidity' are in use in other countries, but in this country it has been generally agreed, upon the suggestion of a committee of the British Medical Association, to regard as 'morbid' all cases in which the temperature reaches 100° F., or over, on two occasions between the second and eighth days. This period will not include the *reactionary* rise just referred to. 'Fever' during the puerperium, as thus defined, is due in the great majority of instances to some degree—it may be slight, it may be severe—of septic infection, and unless some other cause can be determined definitely, such cases must be regarded and treated as septic. There are but few exceptions to the general rule that an aseptic puerperium is also afebrile; it is, however, obvious that febrile affections, quite independent of the puerperium, may attack a lying-in woman, although no septic infection has occurred.

The *pulse-rate* is usually slow (60 to 70) for the first twenty-four to forty-eight hours, and if a reactionary rise of temperature occurs, the pulse-rate does not rise with the temperature; it may even fall as the temperature rises (Fig. 261). After the third day the rate is about normal, varying slightly in correspondence with the temperature. In patients anæmic and debilitated from hæmorrhage the pulse-rate will remain abnormally rapid for several days. In the absence of such causes, a pulse-rate continuously over 90 is always disquieting. A rising pulse with a falling temperature indicates hæmorrhage; when fever is accompanied by a disproportionately rapid pulse, the cause is usually sepsis, but the same phenomena may be observed with pyrexia due to emotional disturbance (Fig. 262).

The Excretions.—Great variations occur in the amount of *urine* excreted during the early days of the puerperium; it appears, however, that the amount is, as a rule, increased for

the first two days, and then gradually falls until it reaches the normal level. Sugar is normally present in the urine after the mammary glands have become active ; it is lactose, not glucose, and is derived, not from the liver, but from the mammary glands. Peptones are present in small amount from the second to the tenth day, and observers are agreed in attributing them to the involution changes going on in

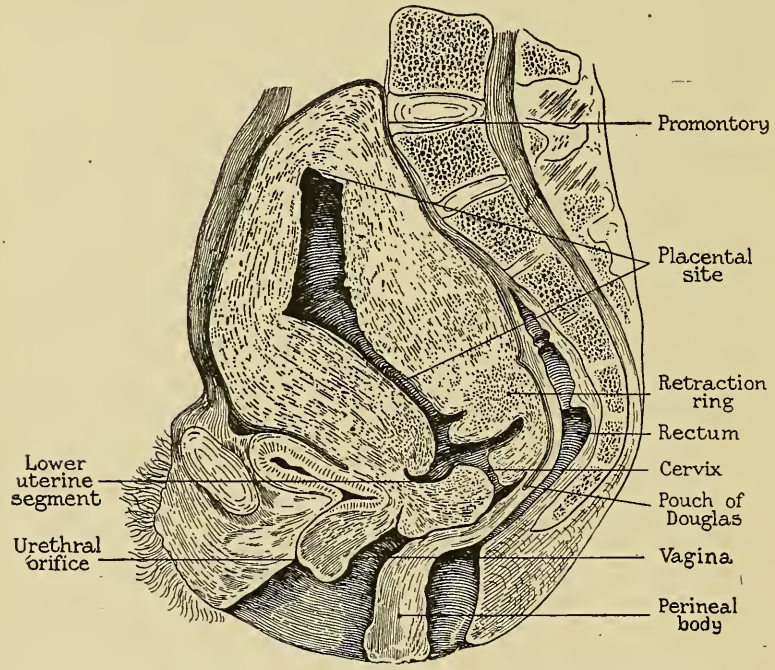


Fig. 263.—Frozen Section of the Pelvis of a Woman who died immediately after Delivery. (Barbour.)

the uterine muscle. Traces of albumen and acetone are frequently found, and the percentages of urea, phosphates, and sulphates are reduced. The act of urination is at first somewhat painful, and temporary retention of urine may occur either from spasm of the sphincter or from paresis of the muscular walls of the bladder.

The *skin* acts freely, and for the first few days the *bowels* are usually constipated.

Blood.—The deficiency in red cells and hæmoglobin,

which is natural in pregnancy, is rapidly made up during the ten days following labour. The leucocytosis, also natural

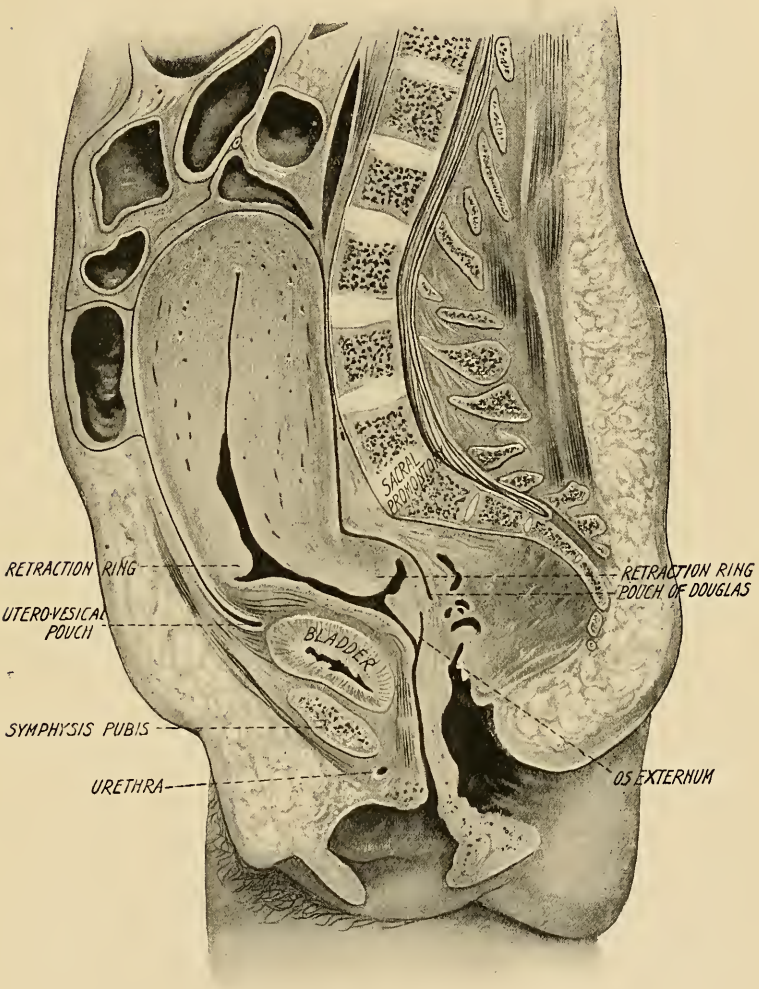


FIG. 264.—The Uterus immediately after Delivery, also from a Frozen Section. The position of the lower segment is clearly defined by the retraction ring and the thinness of the wall immediately below it. The pelvis is contracted and the uterus is much higher than normal. (Barbour.)

to pregnancy, rapidly disappears during the same period, the number of white corpuscles falling from about 21,000

per cm. to 10,000 per cm. (Henderson.) The diminution in the number of leucocytes appears to bear some relation to the amount of the lochial discharge, a free discharge being accompanied by a more marked fall than a scanty discharge. A rapid rise in the number of leucocytes indicates the onset of some septic or inflammatory condition.

The *digestive functions* are, as a rule, depressed during the first two or three days, there is little or no appetite, and in consequence only fluid and easily digestible solid food can be taken.

Body-weight.—There is a slight progressive loss of weight during the first ten days, which is more marked in non-nursing than in nursing women.

II. The Process of Involution.—The *uterus* diminishes rapidly in size for the first ten days, and then more slowly, the whole process requiring six to eight weeks for its completion. According to Whitridge Williams, the uterus loses 50 per cent. of its weight during the first week of the puerperium. The diminution in size can be followed by abdominal examination, and forms a very important clinical index of the course and progress of puerperal involution generally. The condition of the uterus immediately after delivery is shown in the frozen section seen in Figs. 263 and 264. It fills the pelvic cavity, and at its highest point rises slightly above the level of the sacral promontory; the two sections differentiated from one another during labour—viz., the body and the lower segment—are still distinct, and the cervix is once more distinguishable from the latter. In section the wall varies in thickness, measuring from $1\frac{1}{2}$ to 2 inches (4–5 cm.) where it is thickest, to less than $\frac{1}{2}$ inch in the lower segment, and the uterine cavity is almost obliterated by apposition of the anterior and posterior walls. Its total length is $7\frac{7}{8}$ inches (20 cm.); the length of its cavity is $6\frac{1}{4}$ inches (15·5 cm.). Clinically the uterus immediately after delivery forms a large, firm, pyriform swelling in the lower abdomen rising up to the level of the umbilicus (Fig. 260) freely movable, and undergoing slow variations in consistence. Accurate study of the rate at which the uterus diminishes in size can be made only upon the cadaver, and Webster has collated the following table from observations of this kind:

Date	Whole Uterus	Uterine Cavity
Immediately after delivery	$7\frac{7}{8}$ in. long	$6\frac{1}{4}$ in. long
2nd day	$7\frac{1}{8}$,, ,,	$6\frac{1}{4}$,, ,,
3rd ,,	$6\frac{3}{8}$,, ,,	$5\frac{5}{8}$,, ,,
6th ,,	$5\frac{1}{8}$,, ,,	$4\frac{5}{8}$,, ,,
15th ,,	$3\frac{3}{4}$,, ,,	$3\frac{3}{8}$,, ,,

From this it will be seen that during the first week the uterus diminishes much more rapidly than during the second; that the total length diminishes more rapidly than the length of the cavity owing to the rapid reduction in the thickness and bulk of the walls; and that on the fifteenth day it is still very considerably larger than the normal organ (cavity $2\frac{1}{2}$ inches, 6 cm.). Fig. 266 shows that on the third day the lower uterine segment is no longer distinguishable from the rest of the body. Fig. 267 shows great reduction in size on the fifth day; the walls of the cervix are much thinner, and numerous large solid thrombi are seen at the placental site.

The rate of involution varies considerably in different persons, even when the conditions appear normal. The measurements given above must therefore be regarded as approximate, not exact.

In making clinical observations attention is chiefly directed to the height of the fundus above the symphysis pubis. The results of such observations necessarily differ from post-mortem measurements of frozen sections. But it must be recollected that the position of the uterus is largely influenced by the condition of the bladder, and to some extent by that of the rectum. When the bladder is full the whole uterus is elevated, and usually displaced to one or other side, more commonly the right; the hypogastric region being occupied by a soft elastic swelling, dull on percussion, and readily recognisable as the bladder. Consequently, if daily measurements are made, they should always be made immediately after the bladder and the bowels have been evacuated, so as to ensure uniformity. From careful measurements made by Griffith and Stevens at Queen Charlotte's Hospital, it appears that the average height of the fundus on the first day is $5\frac{1}{4}$ inches; by the sixth day it has

fallen on an average to $3\frac{1}{4}$ inches, and by the twelfth day to $1\frac{3}{4}$ inches above the pubes. After the fourteenth day the fundus, as a rule, sinks below the level of the pubes — *i.e.* into the pelvic cavity; but not infrequently this does not occur until the end of the third week. The rate of involution, estimated in this way, is about the same in primiparæ and multiparæ, but in the latter the uterus is rather larger throughout. Roughly speaking, it may therefore be said that at the end of the first week the fundus should be halfway between the pubes and the umbilicus, and at the end of the second week just palpable above the level of the pubes.

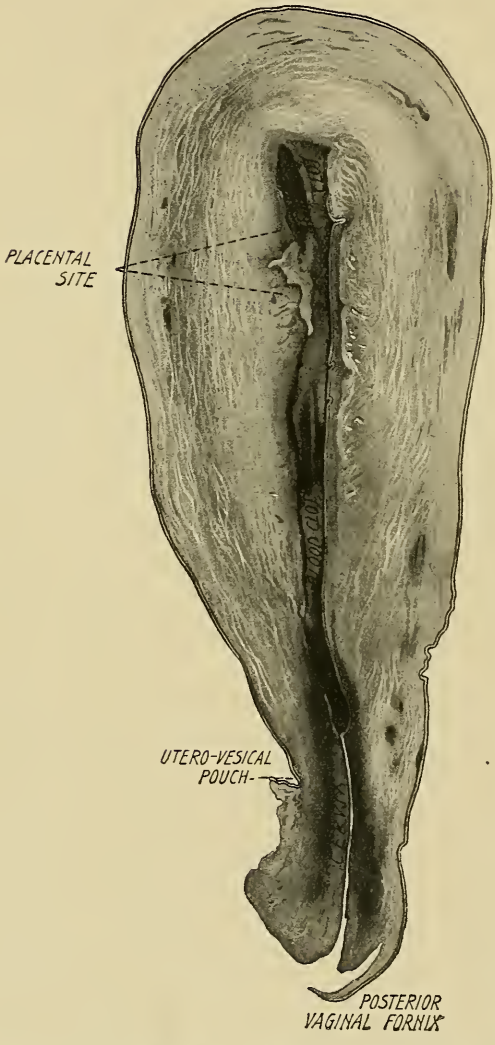


FIG. 265.—Uterus 40 hours after normal delivery. Total length $7\frac{1}{2}$ inches, length of cavity $6\frac{1}{2}$ inches. The blood clot lying in the cavity springs from the ragged area on the anterior wall representing the placental site. The position of the lower segment cannot be made out and the retraction ring has disappeared. (Barbour.)

The importance of systematically observing the involution

of the uterus, as a guide to the normal progress of the puerperium, cannot be over-estimated. When recorded

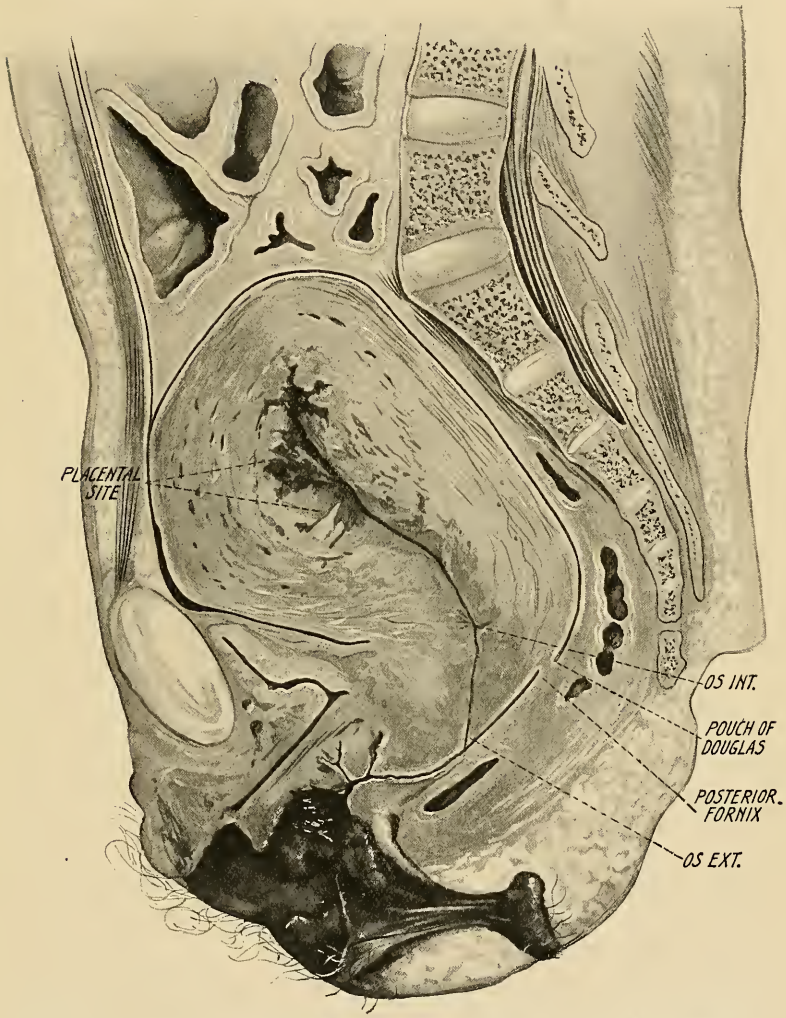


FIG. 266.—Uterus two and a half days after delivery; top of the fundus reaches three inches above the pubes. The placental site is at the fundus. (Barbour.)

upon the temperature-chart in the manner indicated in Figs. 261 and 262, it supplies, along with the temperature-curve, important information as to the general progress of the

patient. There are a number of conditions which unfavourably influence the rate of involution of the uterus. Thus, in multiparæ it is found that after five or six pregnancies have occurred, involution requires appreciably longer than the average. When the uterus has been unusually large, as in hydramnios or twins, when there has been severe ante- or post- partum hæmorrhage, and when the woman does not

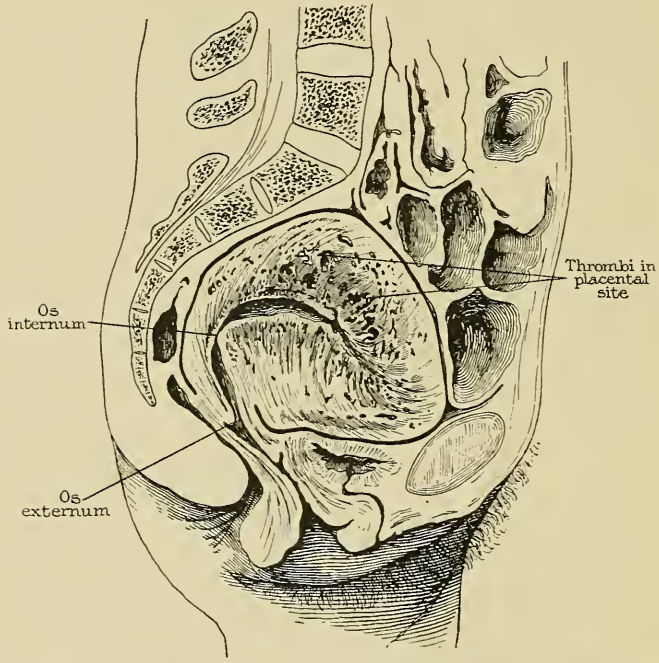


Fig. 267.—Frozen Section of the Pelvis of a Woman who died five days after Delivery. (Bumm.)

suckle her child, involution is delayed. The retention of tissue in the uterus, especially if it should become infected, delays involution, but this does not occur with all varieties of uterine infection (see p. 569).

Structural Changes in the Uterus.—Very careful measurements of the fibres of the uterine muscle during the puerperium have been made by Sänger ; he found that in length they diminish rapidly and at a fairly uniform rate, until at the fifth week they are actually shorter than in the non-

pregnant organ ; in breadth they increase during the first few hours by retraction, and then steadily diminish until at the fifth week they are only a trifle broader than before pregnancy. Fatty degeneration has also been described in the muscle fibres by numerous observers, and there is no doubt that it forms a constant and important feature. Helme has described in the rabbit's uterus a process of degeneration, which he believes to be due to peptonisation of the protoplasm of the muscle cells ; and associated with it he found multinucleated plasmodia (phagocytes) among the degenerating fibres, engaged, as he believed, in absorbing them. Destruction of muscle by phagocytosis has never been demonstrated in the human uterus, and it is generally held that fatty degeneration and peptonisation are the processes chiefly concerned. In this connection it will be recollected that peptones are present in the urine of puerperal women.

The Uterine Vessels.—The involution changes in the vessels have been studied by Goodall. This observer has shown that to a great extent the old vessels first become obliterated by thrombosis and then undergo degenerative changes and disappear, while new vessels are formed to replace them. Further he has demonstrated the appearance of new vessels of small size in the organising clot formed in the lumen of the obliterated vessels. The walls of the old vessels undergo gradual degeneration and absorption, new connective tissue growing in from the uterine wall to replace them and support the small newly formed vessel. This change occurs alike in arteries and veins, and the new vessels are complete in structure, consisting of the usual three coats. Absorption of the walls of the old vessels is often incomplete, and a process of degeneration occurs, converting the remains into 'elastin,' a substance with characteristic staining reactions. The recognition of scattered areas of this substance is therefore equivalent to a diagnosis of parity, and in the condition known as *sub-involution* (imperfect involution) elastin is present in excess (Fletcher Shaw).

The Uterine Mucosa.—A considerable portion of the cavernous layer of the decidua remains attached to the uterine wall ; but here and there bare patches of the muscular

wall may be seen. The membrane is furrowed and folded by the retraction of the subjacent muscle, and soon becomes covered with a layer of fibrin. In seven to eight weeks the mucous membrane is entirely re-formed by proliferation of the remaining epithelial and connective-tissue elements. When the puerperal uterus of the first week is laid open, the placental site may be readily distinguished, as its surface is slightly elevated and nodular, the irregularities being chiefly caused by the extensive thrombosis which has occurred in the sub-placental sinuses (Figs. 266 and 267). Outside the placental site the wall is smooth and uniform.

The Lochial Discharge.—This is the discharge which escapes from the genital canal during the first two to three weeks of the puerperium. For the first twenty-four hours it consists of blood, mostly fluid, but frequently containing small clots ; it then becomes thinner, though still of the colour of recent blood. About the third or fourth day it becomes brownish ; by the end of the first week it is yellowish or greenish ; and then gradually loses all colour, being white and turbid until its final disappearance. Besides red blood cells and fibrin, it contains leucocytes, decidual *débris*, vaginal epithelium, mucus corpuscles, and in the later stages pus cells. Peptones and cholesterin crystals have also been found in it. According to Giles, the amount of the lochia is greater than normal after hæmorrhage during labour, and is habitually greater in women of dark complexion than in blondes, and in those who lose freely during menstruation than in those whose menstrual loss is scanty. It is a common observation that when the uterine cavity has been douched after labour the amount of lochial discharge is always less than normal.

Throughout a normal afebrile puerperium, in the *uterus* the lochia are alkaline in reaction, and usually have a faint sickly odour ; in the *vagina* they become acid, and after the first few days usually contain numerous non-pathogenic bacteria. The bacterial condition of the lochia has been the subject of many contradictory observations, and certain points are still unsettled. It appears certain, however, that in the vagina the lochial discharge does not remain sterile for more than twenty-four hours, while in the cervix

bacteria can always be found after the second or third day. The conditions in the body of the uterus are much more difficult to determine owing to the technical difficulty of obtaining lochia from the uterine cavity without contamination from the cervix and the results obtained have not been uniform. Foulerton and Bonney have shown that with proper technique no bacterial growth can be obtained from the uterus in a large proportion of normal cases, but their series was too small to permit of percentages being calculated. It is probable that the *positive* results obtained in a large proportion of cases by others have been due to faults of technique permitting of cervical contamination. We may, therefore, regard it as highly probable that in the normal puerperium the uterine cavity remains sterile for several days. Under morbid conditions the lochia may be suddenly suppressed, or may become fœtid from infection; or may be altered by fresh hæmorrhage. When involution is delayed, they may persist longer than usual, although not abnormal in characters. The source of the lochial discharge is mainly the uterine cavity, but cervical, vaginal, and vulval lacerations also contribute to it to some extent.

After-pains.—In multiparæ the normal puerperium is usually accompanied for the first one or two days by painful contractions of the uterus, which are known as after-pains. These when *slight*, are probably of service in maintaining the necessary close retraction of the uterine wall, and they require no treatment. *Severe* after-pains are usually due to the presence of some foreign body, such as a blood-clot or a piece of membrane or placenta. From imperfect retraction blood-clot may form in the uterine cavity even after it has been completely emptied at the end of the third stage ; this is much more likely to occur with a multipara than with a primipara, for retraction is usually adequate in primiparæ. But when the uterus is not empty, after-pains may be met with in a primipara just as in a multipara. They should be treated by stimulating the uterus to expel the foreign body. This may be done by giving a teaspoonful of liquid extract of ergot every four hours, by massaging the uterus per abdomen, and by a hot vaginal douche (115°—118° F.) of boiled water, or a mild antiseptic, such as lysol, a teaspoonful

to a quart. The expulsion of a blood-clot usually follows in a few hours, revealing the cause of the trouble.

Severe after-pains sometimes occur with a completely retracted and empty uterus ; we do not know what may be the exciting cause of the painful contraction in such cases. Pains of this character can usually be cured by administering a dose of antipyrin (10 grains), which should be given with a stimulant, such as 20 to 30 drops of sp. ammoniæ aromat.

III. **Management of the Puerperium.**—There are three objects to be kept in view in the management of the lying-in woman : (1) to maintain asepsis in the genital canal ; (2) to enforce a sufficient period of rest ; (3) to regulate the function of lactation.

(1) *Asepsis.*—If the antiseptic precautions observed during labour have been successful, the genital canal will be sterile at the commencement of the puerperium ; and the principal care of doctor and nurse is to prevent infection from reaching it. The greatest possible care must accordingly be taken of the vulva. The lochial discharge should be received upon sterilised pads of absorbent wool or gauze, or these substances impregnated with an antiseptic such as corrosive sublimate ; the pads should be removed and burned as soon as they become soiled. During the first three or four days the vulva should be frequently swabbed with a solution of lysol (℥j to Oj). It is essential that the nurse's hands and all the appliances used, such as catheters and vaginal nozzles, should be as carefully sterilised during the puerperium as during labour.

Vaginal douching is unnecessary when the puerperium runs a normal course. The aim of management should be to preserve the genital tract from contamination, rather than to endeavour to destroy organisms which may have gained access to it. No amount of vaginal douching can compensate, for instance, for careless treatment of the vulva. Vaginal douching, in addition to being unnecessary, may become positively dangerous, when carried out carelessly or by untrained persons, by introducing into the vagina organisms which would not otherwise obtain access to it. Routine vaginal douching has accordingly been almost universally abandoned. Yet there is little doubt that the mechanical clearing of the vagina by the douche is comfort-

ing to the patient, and prevents stagnation of the lochia in the vaginal fornices—a condition very apt to occur while the patient continuously maintains the recumbent position. These advantages are, however, not of sufficient importance to outweigh the attendant risks. Decomposition of the lochia, indicated by fœtor, is the most frequent indication for the douche in an afebrile puerperium, and a solution of 1 in 4,000 of biniodide or perchloride of mercury is the best solution to employ under these circumstances. Hot antiseptic or sterile douching may also be required for the control of puerperal hæmorrhage, or to promote the expulsion of blood-clot or membrane retained in the uterus.

Other antiseptics which may be employed for vaginal douching are lysol, izal or cyllin (5j to Oj), or carbolic acid (1 in 60). A solution of iodine (5j of tinct. iodi to Oj of water) may also be used, and is frequently employed as an intra-uterine douche, on account of its non-poisonous nature. When douching the *uterus* in the early puerperium the same solutions may be employed in one-half the strength used for the vagina. Although these solutions are useful for douching, in sterilising the skin mercurial solutions are much more efficient than any others. It must be remembered that by the indiscriminate use of mercurial douches acute mercurial poisoning may be set up, and some such cases have proved fatal. The symptoms of mercurial poisoning from absorption are the same as those produced when the poison is taken by the mouth—viz., vomiting, diarrhœa, salivation, acute gingivitis; sometimes in fatal cases patches of sloughing in the mucous membrane of the colon have been found.

When a perineal laceration has been sutured the wound should be kept clean and covered with strips of lint spread with boric acid ointment; the ointment should be re-sterilised daily by boiling the pot containing it.

A well-ventilated room free from risk of contamination from faulty drain-pipes, and clean fresh bed-linen and bed-garments, are valuable aids to the maintenance of asepsis; yet in the homes of the poor, where these *desiderata* cannot be obtained, the local precautions indicated will succeed, in all but a few cases, in preventing infection.

(2) *Rest.*—Rest in bed, but not necessarily in the hori-

zontal position, should be maintained until the uterus has sunk below the symphysis pubis and the lochial discharge has become colourless. When ordinary avocations are resumed with the uterus as large as it is on the tenth day of the puerperium, it is clear that there must be liability to prolapse, retroversion, and sub-involution. The poor habitually neglect this precaution, but there is little doubt that they suffer in consequence. After the first forty-eight hours the patient may be propped up with pillows or a bed-rest, and this position is of advantage in promoting the escape of the lochia. Light and nourishing food, both solid and fluid, may be given freely during the first two days; an aperient should be administered on the evening of the second day, and after this ordinary food may be taken. The action of the bowels is usually sluggish while the patient is confined to bed, and a daily mild aperient may be required, or an enema if the latter will suffice. The condition of the bladder must be carefully watched during the first two days; if retention occurs resort should not be had to the catheter until means of procuring spontaneous evacuation have been tried. The strictest antiseptic precautions are required for this simple procedure. Occasionally the bladder is imperfectly evacuated by the natural efforts and becomes gradually over-distended, causing great discomfort. This condition will be recognised by careful abdominal examination. Emotion and excitement may produce alarming rises of temperature in lying-in women; therefore, in private practice, patients should be practically isolated for the first few days. Sleep almost always comes naturally to a lying-in woman, but hypnotic drugs should be given without hesitation if sleep is absent or insufficient, for sleeplessness may be a prelude to serious mental complications.

In the case of patients who are able to afford it, general massage by a skilled person may be used with great benefit after the first week. This aids digestion and promotes the natural action of the bowels, improves the general condition, which is apt to suffer from muscular inaction, and by improving the tone and condition of the abdominal muscles helps to restore these structures, which have necessarily suffered from stretching in pregnancy. To women who set store upon their 'figure' this also a point of some æsthetic

importance. Permanent loss of power of the abdominal muscles is in all probability an important predisposing cause of displacement of the pelvic and abdominal viscera.

The 'Rational' Puerperium.—Under this somewhat misleading name an attempt has been made to show that it is inadvisable to keep women in bed for more than two days after labour, and that they will be benefited by being encouraged to get up, and sit up or walk about, whenever the obstetric conditions are in all respects normal. The main reasons assigned for this innovation are that pregnancy and labour are not morbid but physiological processes, and that primitive or uncivilised woman does not observe a lying-in period and apparently does not require it. The name given to this method of management is unfortunate and regrettable, inasmuch as it introduces prejudice by implying that the alternative method is irrational. The reasons assigned for regarding the method as 'rational' hardly deserve consideration, for if pregnancy and labour are not morbid processes they are attended by greater risks and may be followed by more serious sequelæ than many recognised diseases. The example of the uncivilised woman, also, is not in all respects to be enjoined upon others; she does not practise the use of antiseptics in labour, but we do not for that reason regard them as irrational. The advocates of this form of management of the puerperium have undoubtedly shown that no *immediate* ill-effects follow from allowing a lying-in woman to get up and walk about at an earlier period than has usually been thought desirable. Whether these women suffer more than others from the remote ill-effects of child-bearing has not yet been shown.

(3) *The Process of Lactation.*—By lactation is meant the establishment of functional activity in the mammary glands. Certain signs of activity, which have been already described, are present in the breasts during the greater part of the period of pregnancy. For forty-eight hours after delivery no further change takes place; during the third day the breasts undergo rapid enlargement, becoming tense, nodular, and often very tender to the touch, the skin being tense and glistening. On the fourth day the condition of distension reaches its height and is more severe in a primipara than a

multipara. The breasts are then full of thick yellow secretion which can be readily expressed, or may escape spontaneously from the nipple. During the first week the secretion is known as *Colostrum*. Considerable local pain and general discomfort usually attend the ' coming of the milk,' and a rise of one or two degrees of temperature may occur for a few hours. Suckling and spontaneous overflow speedily relieve the overdistension of the glands, and in one or two days all symptoms of discomfort disappear, although active secretion will continue for many months. After suckling

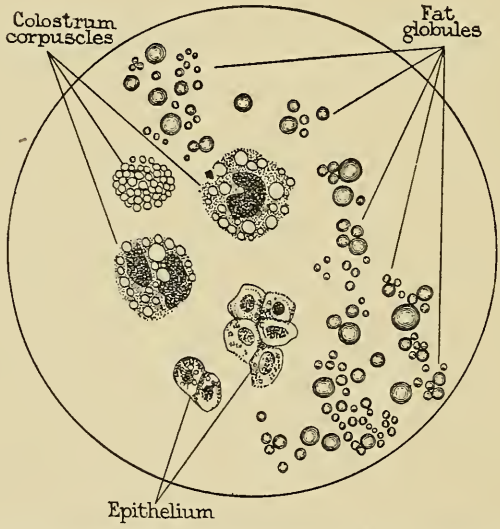


Fig. 268.—The Elements of Human Milk (Colostrum). (Bumm.)

for two or three days the secretion becomes thinner and less yellow. The mammary secretion is established somewhat sooner in a multipara than in a primipara, and the initial distension is less severe.

Colostrum possesses certain special features which are sometimes of forensic importance as evidence of recent delivery. Its naked-eye appearances have been indicated ; under the microscope it is seen to contain, besides the polymorphous fat-globules characteristic of milk, certain special elements which have been named *colostrum corpuscles*. These are leucocytes containing large droplets of fat. Epithelial

cells in a more or less advanced state of fatty degeneration, which have been detached from the walls of the glandular acini, are also seen (Fig. 268). They disappear after the first few days of suckling. The anatomy of the function of lactation is fully described in text-books of physiology, and need not be referred to here.

The composition of human milk will be referred to in connection with Artificial Feeding (p. 621).

The child cannot be fed regularly from the breast until the secretion becomes fully established about the third day. During the first two days it may be allowed to draw what it can from the breasts occasionally ; probably more food will not be required than it can thus obtain, but if hunger is indicated by restlessness and crying, small quantities of boiled water or of diluted cow's milk may be given in addition (see Infant Feeding). It is necessary to prepare the nipples carefully for the process of suckling during the last few weeks of pregnancy, especially in the case of a primigravida. The skin of the nipples and areolæ should be cleansed once or twice daily, bathed with boric acid lotion 1 in 40, and a mild antiseptic ointment, such as boric acid and white vaseline (1–40), gently rubbed into it. If the nipples are depressed a breast-pump may be used to draw them out, and with the additional help of frequent gentle manipulation, exciting the reflex erection of the nipple by its muscles, the depression can usually be overcome.

After the third day the infant should be fed from the breast at regular intervals of two hours during the day and three or four hours during the night. If the breasts should become painful from overdistension and the temperature raised, hot fomentations should be applied, and the breasts gently massaged, rubbing towards the nipple. At this stage the ducts sometimes become partly blocked, impeding the escape of the secretion, and on the removal of the obstruction the pain and distension disappear.

In giving the breast, great care should be taken to adjust the mother's position so that the child can reach the nipple comfortably without having to turn or stretch its neck in the attempt. Difficulty in getting the child to take the breast is often due to neglect of this simple precaution. In ten to fifteen minutes enough will usually have been obtained to

satisfy the child, and it will then fall asleep or cease to suck. After each feed the mouth should be cleansed with a piece of cotton-wool dipped in boric lotion ; this is required because a little milk accumulates in the cheeks, where it will ferment if allowed to remain, and give rise to digestive disturbances, or to thrush. The nipples must also be cleansed with boric lotion and carefully dried every time the child has been fed. A piece of clean lint, or preferably a small pad of sterilised cotton, should be kept applied to the nipple, and the breasts lightly supported by a binder. In this way the nipples can be protected from infection, and the occurrence of mastitis prevented.

Cracked or Sore Nipples.—Primiparæ frequently suffer from the formation of fissures of the nipple at the commencement of the process of suckling. They may occur either at the apex or the base, and in the latter position are sometimes overlooked. They begin as slight abrasions caused by the gums of the child, or by the vigorous use of its buccinator muscles. If the secretion is scanty, or if the child is allowed to take the breast before any secretion can be obtained, unusually vigorous suction will be made, and abrasions may thus be formed upon the nipple. Such abrasions are often seen, but as a rule they give rise to little pain and heal spontaneously in twenty-four to forty-eight hours. They may, however, become infected, giving rise to fissures. These render the process of suckling extremely painful, and may lead, if neglected, to the formation of a mammary abscess. If at all deep they bleed during suckling, and the blood, being swallowed along with the milk, may later on be rejected so as to create the impression that the child is suffering from hæmatemesis.

When the nipple first begins to be painful absolute alcohol should be freely painted over it after each feeding time, the nipple being previously carefully cleansed with boric acid lotion and dried. In mild cases fissures can be successfully treated as follows : A nipple-shield of glass or rubber must be used for suckling, so as to protect the nipple from the child's mouth ; in addition to the usual cleansing, the nipple should be painted with a mild antiseptic such as boro-glyceride, glycerine and carbolic acid 1–20, or dilute sulphurous acid ; finally it should be covered with wet boric

lint. Dry dressings are unsuitable, as free drainage from the fissure must be ensured. When the fissures are severe, suckling from the affected breast should be stopped for twenty-four hours, the nipple disinfected, by painting it with 1-500 perchloride lotion touched with nitrate of silver, and the whole breast tightly bandaged to arrest the secretion. The unaffected breast will probably suffice for the child's needs for this period ; if not, the bottle may be given as well (see p. 618). In intractable cases suckling may have to be given up altogether.

As a rule nursing women do not menstruate, but there are frequent exceptions. Women who do not nurse usually begin to menstruate in from four to six weeks after their confinement. When lactation ceases menstruation usually returns after about the same interval.

Puerperal Infection

Under the term ' puerperal infection ' is included a series of febrile disorders of the lying-in period due to the active development of certain pathogenic bacteria, which enter the body through wounds of the genital tract ; in the great majority of cases these organisms are introduced from without, but in a few instances they may have been present in the genital tract at the time of labour. It must be borne in mind that puerperal infection may occur after abortion as well as after labour.

All controversy as to the nature of ' puerperal fever,' ' child-bed fever,' or ' milk fever ' has long since been set at rest, and we now know it to be due to sepsis or wound-infection. To a Scotch physician, Robert Gordon, of Aberdeen, belongs the credit of first publicly declaring his belief that puerperal fever was infectious and could be carried from patient to patient by the doctor or the nurse (1795). About 1840 to 1843 Oliver Wendell Holmes in the United States, and Semmelweiss in Vienna, independently recognised that puerperal fever could also be set up by infection carried from the dead-house. To Semmelweiss has been now adjudged the chief credit of this important discovery ; but his work was to a great extent neglected for thirty years, when the discoveries of Lister placed the matter upon a scientific basis

by showing that bacteria were the agents by which surgical infection was produced and propagated. Doléris, working with Pasteur, first showed in 1880 that streptococci could be found in the uterus in cases of 'puerperal fever,' thus definitely bringing the disease into the class of 'wound-infections,' and demonstrating its close relation to suppurative processes. Experience has shown that infection from these latter sources is even more serious than infection from the cadaver.

The combined work of these observers has resulted in the practical disappearance of puerperal infection from lying-in hospitals, and has undoubtedly been the means of saving the lives of innumerable lying-in women. In the time of Semmelweiss outbreaks of puerperal infection occurred from time to time in maternity hospitals, sometimes attended by the appalling mortality of 60 to 75 per cent. ; and seldom did the mortality from puerperal fever in these institutions fall below 10 per cent. At the present time the mortality from puerperal fever in such hospitals is about 1 to 2 per 1,000, and epidemics are unknown. No more striking instance than this exists of the value of Lister's principles. But puerperal infection still occurs, although not in epidemic form, and the returns of the Registrar-General show that between 1893 and 1903 the number of deaths from this cause in England and Wales averaged nearly 2,000 per annum. Boxall showed that during this period of ten years there was no general improvement in the mortality from puerperal infection, although it must be assumed that the medical profession has become thoroughly convinced of the importance of the routine application of antiseptic principles to obstetric work.

A. **Causation.**—There are three factors to be considered in the causation of puerperal infection : (I.) The bacteria. (II.) The channels of infection. (III.) The powers of resistance of the infected tissues.

I. **The Bacteria.**—Since puerperal infection gives rise to a whole group of disorders, it is not surprising to find a variety of different micro-organisms concerned in its causation. These may be conveniently divided into three groups : (a) *anærobic putrefactive* (*saprophytic*) *organisms ;* (b) *pyogenic organisms ;* (c) *certain specific organisms.*

(a) *Saprophytic organisms* are bacteria which grow and

multiply in dead tissues, causing the phenomena of putrefaction; they do not invade the body generally, and they tend to disappear spontaneously when the pabulum upon which they flourish is exhausted; the general effects which they produce are due to the absorption into the circulation of the noxious products of their growth and development—the *toxins*. These organisms are mostly bacilli, but their varieties are very numerous and do not require full mention. The following species have been found in cases of puerperal infection:

(1) Bacillus proteus vulgaris.
(2) Bacillus septicus.
(3) Bacillus aerogenes capsulatus.

They are the chief agents in the production of the clinical condition to be described later on as *uterine sapræmia*.

(b) *Pyogenic Organisms*.—These are the common organisms which produce suppuration and sepsis; those which have been found in connection with puerperal infection are:

(1) Streptococcus pyogenes.
(2) Staphylococcus pyogenes.
(3) Bacillus coli communis.
(4) Bacillus pyocyaneus.

These organisms, no matter what may be the part of the body first attacked by them, tend to spread by the lymphatics and blood-vessels so as to cause general septicæmia. They are the organisms which are most to be feared by the obstetrician, for their distribution in crowded centres of population is almost universal, in dust, in soiled clothing, and even in the atmosphere. The discharges from a case of puerperal fever usually contain a virulent strain of organisms of this group. Every focus of suppuration forms a centre of distribution from which they may be spread broadcast in countless numbers, and thus become the cause of fresh wound-infection. It is obvious that the presence of suppurating sores upon the hands or arms of the medical attendant or nurse, or even upon the body of the patient, must involve the most serious risk of infection by direct contact. And, further, the transmission to a lying-in woman of organisms from other patients suffering from these conditions can only be avoided by the most scrupulous surgical cleanliness.

By far the most important member of this group is the streptococcus, which is present in pure culture in 40 to 50 per cent. of cases of uterine infection (Lea). In a series of ninety-six cases Western found streptococci in 80 per cent., and of these 76 per cent. were pure cultures. Many different varieties of streptococcus are known, and that concerned in puerperal sepsis does not appear to be a specific variety, although some attempts have been made to show that it possesses specific cultural reactions. In addition it is frequently present in association with other organisms, one of the most frequent associates being the bacillus coli. The most severe of all cases of puerperal fever are due to these two organisms, either alone or in company with one another. Streptococci occur in a variety of different degrees of virulence, and there are many varying types. Some are saprophytic only, or even apparently non-pathogenic, and it has been mentioned that such organisms may occur in the discharges of healthy lying-in women. Organisms belonging to the same classes may be found in the skin of the vulva and in the vaginal secretions of pregnant and non-pregnant women, and also in the lochial discharges in normal cases.

(c) *Specific Organisms.*—The following specific organisms have been found in cases of puerperal infection :

(1) Diplococcus gonorrhœæ.
(2) Bacillus diphtheriæ (Klebs-Löffler).
(3) Pneumococcus.
(4) Bacillus tetani.
(5) Bacillus typhosus.

The actual relation of these latter organisms to the causation of puerperal infection is a matter of some uncertainty. There is reason to believe that the two first-named may in certain cases be the sole, or at any rate the principal, cause of infection. The three last-named probably occur only in association with the pyogenic cocci, although this is denied by some authorities. The gonococcus produces as a rule only local pelvic inflammation ; both the pneumococcus and the bacillus coli may produce virulent forms of peritonitis or general septicæmia. The Klebs-Löffler bacillus produces in the genital tract the same

species of false membrane which characterises throat-infection by the same organism. Puerperal tetanus occurs, but is an extremely rare condition.

Mixed Infection.—Puerperal infection is not always due to a single species of organism; and, further, in a large number of cases it cannot even be said that the organisms concerned belong to a single member of the three great groups just described. Saprophytes may be found in company with pyogenic cocci, and the latter with certain of the specific organisms; or members of all three groups may be associated in a single case. This fact, as we shall see, exerts an important influence upon the clinical features and treatment of cases of puerperal infection. It is believed that the most virulent cases are those due to mixed infection. It also appears that the pyogenic cocci may sometimes assume a saprophytic *rôle*, remaining confined to the uterine cavity, and producing symptoms of sapræmia alone.

Autogenetic and Heterogenetic Infection.—In almost every case of puerperal infection the organisms are introduced into the genital tract from without (*heterogenetic infection*), by surgically unclean fingers, instruments, diapers, or other matters applied to or introduced within the vulva. It must not be forgotten that the vulva itself, like all other areas of skin, usually contains numerous organisms, and that hands or instruments, after being carefully sterilised, may become re-infected in passing through it. The risk of hetero-infection will be greatly increased by the presence of local sores, such as fistula *in ano*, vulval furuncles, etc., or of sores upon the hands of the medical attendant or nurse, or by contact with other sources of infection, or by insanitary personal or general surroundings. But of all modes of infection, the one most to be feared is the carriage of organisms from one case of puerperal infection to another. Puerperal infection by the bacillus coli is not necessarily autogenetic—*i.e.*, the organisms may be derived from external sources, not from the intestinal tract of the patient. So far as we know, this bacillus only becomes virulent to its host in certain morbid conditions (injury or disease) of the bowel. But it occurs widely distributed in dust, especially road dust, and may therefore be introduced into the genital canal as the result of imperfect surgical cleanliness. Sewer gas was at one time

regarded as a potent cause of puerperal infection ; this was probably an error, for sewer gas contains, as a rule, no bacteria, and the effects it produces upon the lying-in woman are those of sewer-gas poisoning, not wound-infection.

By *autogenetic infection* is meant infection of the genital tract by organisms existing in or near it before labour. The possibilities of auto-infection are, however, strictly limited, and this variety should never be diagnosed in a particular case without the clearest demonstration. It cannot be said that anything like satisfactory evidence of auto-infection has ever been furnished in the case of any organism except the gonococcus. Puerperal infection may, however, be caused by gonococci which, during pregnancy, have been lurking in some part of the vagina or cervix, or even in the decidua or the Fallopian tube. The possibility of this organism remaining latent for a considerable time, and then assuming well-marked activity on being transferred to a new location, is well known, and doubtless accounts for its occasionally causing serious results in lying-in women. In this way acute ascending gonorrhœal inflammation may arise, involving not only the uterine cavity, but also the ovaries, tubes, and peritoneum. Again, when such local conditions are present as carcinoma of the cervix, appendicitis, cystitis, or pelvic abscess, acute infection of the genital tract from these sources may also occur spontaneously. But when puerperal sepsis accompanies acute specific fevers such as scarlatina, typhoid, or diphtheria, it is much more probable that the infection has been carried from without than that it has reached the genital canal through the circulation, although it cannot be denied that this is theoretically possible.

It must not be forgotten, however, that bacteria are found in normal conditions in the lower part of the genital tract. Such organisms are probably non-virulent and incapable of producing an acute general infection ; they may, however, be the cause of the milder forms of local infection described below.

II. The Channels of Infection.—(a) *Lochia.*—The normal defence against infection offered by the healthy vaginal secretion with its specific bacillus is lost, and the alkaline lochia, rich in albuminous material, provide an excellent culture-medium for any organisms which may obtain

access to them. The condition of the genital tract is, accordingly, such as to offer special facilities for bacterial infection.

(b) *Dead Tissue.*—A certain amount of dead tissue is always present in the puerperal uterus—viz., fibrin, blood-clot, and a thin layer of decidua which undergoes necrosis and is cast off. This may be supplemented by fragments of placental tissue or chorionic membrane which remain attached to the uterine wall. Thus the conditions requisite for the growth of saprophytic organisms always exist in greater or less degree in the puerperal uterus. In difficult or instrumental labour, areas of sloughing from prolonged or excessive compression may also occur.

(c) *Wounds.*—After every normal labour the continuity of the surface of the genital tract is broken by separation of the placenta, and by the more or less considerable lacerations which usually occur in the cervix or near the vulva; the latter are more severe and of more frequent occurrence in primiparæ than in multiparæ. Through these wounds toxins may be absorbed into the circulation, or pyogenic organisms, if present, may invade the tissues of the body generally. When introduced into wounds of the cervix and vaginal roof, organisms will find, in the lymphatic channels, a ready way of access to the cellular tissue of the broad ligament, and may thus give rise to pelvic cellulitis. It is probable, from what is known of the pathological anatomy of puerperal sepsis, that generalised infection usually occurs by extension from an infected uterus, and not by absorption from wounds of the cervix or vagina. Bacteriological evidence has, however, been adduced by Foulerton and Bonney which appears to indicate that mild cases of puerperal fever may be due to infection through lacerations of the lower part of the genital tract, the uterus remaining uninfected and its contents sterile. But severe cases of puerperal fever are probably in all instances the result of uterine infection.

III. The Powers of Resistance.—The effects produced by bacterial infection depend partly upon the number and degree of virulence of the organisms, and partly upon the resistance offered by the tissues to their development. The general resistances are reduced by anything which exhausts or debilitates the patient such as previous ill-health, pro-

longed or difficult labour, hæmorrhage during or after labour, albuminuria, pre-existing pelvic inflammation, etc. Under

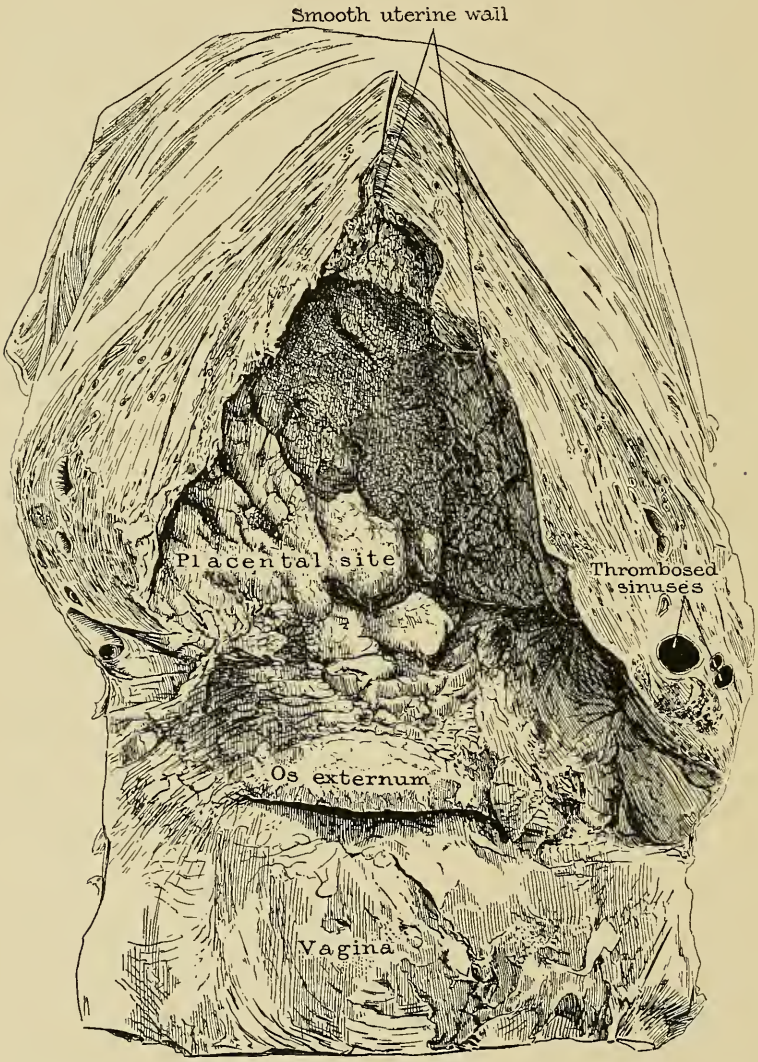


Fig. 269.—Uterus from a Case of Placenta Prævia and Puerperal Septicæmia ; Streptococcic Infection ; Death on Fourth Day.

It will be noticed that the thrombosed placental sinuses are in the lower uterine segment.

such conditions the normal means of defence against bacterial invasion are inhibited or impeded, and no effective opposi-

tion can then be offered by the tissues to the attack of the organisms. In addition it must be borne in mind that the risks of infection may be increased by the character of the labour, and especially by such conditions as premature rupture of the membranes, or prolonged labour, and such operative procedures as induction of labour, forceps, version, etc. The conditions just named are accordingly often spoken of as *predisposing causes* of infection.

B. **Pathological Anatomy of Puerperal Infection.**—Cases of extreme virulence, which rapidly reach a fatal termination in from two to three days, are sometimes met with, in which practically no morbid changes can be found in the genital tract. These cases are usually due to streptococcic infection, the organisms directly entering the blood and lymph vessels, and producing practically no reaction at the points of entry. Death is due to an overwhelmingly rapid formation of toxins within the circulation. In the majority of cases of puerperal infection, however, well-marked alterations are found in the genital tract, but they differ greatly in their nature and distribution.

(1) *The Uterus.*—The general condition of the wall of the uterine cavity is variable. In pure streptococcic infection it is believed to be usually smooth and uniform, with little evidence of superficial necrosis. Thus in Fig. 269 the greater part of the wall is smooth, but the placental site presents the usual elevated and irregular appearance. In mixed infection, on the other hand, the wall is shaggy and irregular from the presence of necrotic tissue.

The condition of the uterine wall is, in general terms, similar to that of an infected wound in any other part of the body ; but the local appearances depend to a great extent upon the type of organisms present. It is generally agreed that two varieties may be distinguished, named *putrid* (*saprophytic*) and *infective* (*septic*) *endometritis*.

Putrid Puerperal Endometritis.—In this condition the uterus is large and flabby, and usually contains adherent fragments of membranes, placenta or blood-clot, and frequently, but not always, an offensive odour is noticeable. There may be a thick layer of decidua or polypoid masses may be found on the placental site ; sometimes bubbles of gas are visible in the decomposing tissues. This form is

mainly due to infection by mixed putrefactive bacteria, but the streptococcus and bacillus coli are also not infrequently present. On microscopic examination of the uterine wall, a well-marked zone of leucocytic infiltration is found beneath the necrotic layer ; this zone appears to form a barrier to the advance of the infecting organisms, for none are found either in it or in the tissues lying beneath it (Fig. 270). Accordingly,

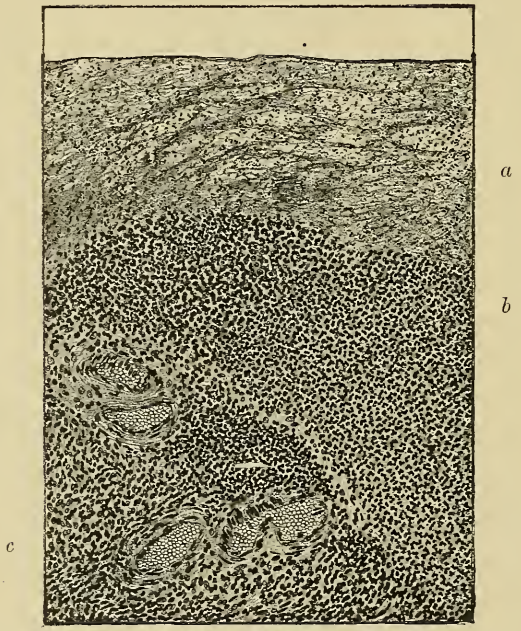


Fig. 270.—Puerperal Endometritis, showing marked development of the Leucocytic Zone. (Whitridge Williams.)

a. Fibrin layer. *b*. Leucocytic zone. *c*. Muscular wall with vessels.

with this variety of puerperal endometritis, symptoms of general infection are absent, for the dissemination of the organisms is prevented.

Infective Puerperal Endometritis. — In this form the uterus is small, the cavity lined with a greyish layer of exudation, there are no retained tissues to be seen, there are no bubbles of gas, and no fœtor. It is caused by the group of pyogenic cocci, of which the streptococcus is the most frequent, being found either alone or in association in 60 to

70 per cent. of cases (Lea). This variety may, however, also be due to the bacillus coli or the gonococcus. On microscopic examination it is found that the zone of leucocytic infiltration, although present, is less extensive than in the first-named variety, and numerous organisms will be found to have invaded it—*i.e.*, the barrier to dissemination of the organisms is feeble. In some cases the leucocytic zone is not continuous, presenting gaps here and there, through which the organisms can be seen to have made their way freely into the lymphatic spaces and blood-vessels of the subjacent muscle. In this way the frequency with which streptococcic uterine infection is accompanied by symptoms of general septicæmia can be anatomically explained. Occasionally, when the leucocytic zone is complete, streptococcic endometritis may produce only symptoms of localised uterine infection (sapræmia).

In cases of mixed infection by saprophytic and pyogenic organisms, atypical appearances will be presented in the uterus. Adherent fragments of placenta or chorion may be found in either variety of puerperal endometritis.

The *muscular wall* of the uterus also is usually more or less inflamed (*metritis*) in both forms of puerperal endometritis. In rare instances of the septic variety multiple small interstitial abscesses may form. In very rare instances sloughing of more or less extensive areas of the muscular wall occurs—the so-called *metritis desiccans*. The venous channels in the general uterine wall are frequently found thrombosed and inflamed (*phlebitis*), and small collections of pus may sometimes be found in the thrombi, and outside the vessel walls in the tissues around them. The general muscular tissue is said to be unusually soft and friable, and specially liable to perforation by such instruments as the curette.

The *serous coat* may escape altogether, or in cases of great severity, patches, or a complete coating, of lymph may form upon it ; in such cases the whole of the pelvic peritoneum, along with the tubes and ovaries, is generally inflamed (*perimetritis, pelvic peritonitis*). Infection of the peritoneal coat may be brought about by extension from the infected uterine cavity through the lymphatics, or through the advance of the infection by direct continuity from the

uterine cavity to the mucous membrane of the Fallopian tubes, and through the abdominal ostia to the pelvic peritoneum.

(2) *The Cervix, Vagina, and Vulva.*—Lacerations of these parts, when infected, assume the appearance of ulcers with a dirty greyish base, produced by the formation of a false membrane consisting of the superficial necrosed tissues. In cases of severe perineal lacerations which have become infected, superficial sloughing may occur over large areas of the injured tissues. Sometimes areas of sloughing are met with in the anterior vaginal wall. They are produced by prolonged and severe compression of the part between the fœtal head and the pubes, or between the forceps and the pubes ; they are accordingly most often met with after a long and difficult second stage. If the patient survives, such sloughs separate during the first seven to ten days of the puerperium, and usually they produce a vesico-vaginal fistula, since the base of the bladder is necessarily involved in the compression and sloughing.

(3) *Pelvic Cellular Tissue.*—Large inflammatory effusions (*cellulitis*) may be met with in one or both broad ligaments ; or they may be so extensive as to involve the whole of the pelvic cellular tissue and spread to that of the iliac fossa and anterior abdominal wall. Such an effusion between the layers of the broad ligament is often called a *broad-ligament phlegmon*. The cellular tissue usually becomes infected by lymphatic extension from wounds of the cervix ; cellulitis is probably always accompanied by a certain amount of uterine infection, but clinically the condition of the cellular tissue obscures that of the uterus, and the case is regarded mainly, if not entirely, as one of cellulitis. On post-mortem examination a recent cellulitic effusion forms a spongy mass, from which a clear or slightly turbid fluid exudes on section.

(4) *Peritoneum, Fallopian Tubes, and Ovaries.*—Peritonitis of variable extent is usually found in fatal cases of puerperal fever. A certain amount of pelvic peritonitis often accompanies severe cases of uterine infection which recover, and if limited to the pelvic cavity it is not necessarily fatal. Occasionally acute general peritonitis may be set up by an infected uterus. The infection may occur by direct lymphatic spread, but sometimes may arise from lacerations

of the uterus or vagina, through which direct infection may occur; this is often seen in rupture of the uterus, or after perforation of the uterus from induction of abortion by unskilled persons (criminal abortion). The Fallopian tubes may become infected by direct spread from the uterine cavity, and from them the infection spreads to the ovaries and the pelvic peritoneum. Pyosalpinx and ovarian abscess sometimes form, either rapidly or after a considerable interval. These, however, occur more frequently with gonorrhœal than with other forms of infection.

(5) *Pelvic Veins.*—The thrombosed vessels beneath the placental site frequently become infected by organisms which penetrate the blood-clot. Thence they spread in the sub-endothelial connective-tissue along the walls of the vessels—chiefly the veins, setting up a spreading phlebitis. Phlebitis may spread from the infected uterus into the broad ligaments; thence it may pass upwards through the ovarian veins to the renal veins, and through the iliac veins to the inferior vena cava, and the resulting long line of blood-clot may even reach the right ventricle. In other cases it passes downwards into the femoral vein, causing femoral thrombosis—a variety of the condition clinically known as *phlegmasia alba dolens* (see p. 598).

Septic phlebitis is probably to be regarded as a defensive reaction against the spread of the infection; as has been mentioned, the most virulent infections do not show it at all. Following upon the phlebitis, coagulation of blood occurs, and the affected vessel thus becomes partially or wholly blocked (thrombosis). The clot thus formed is infective, and in many cases minute particles become detached as emboli, and being carried to distant parts by the blood stream the condition known as *pyæmia* results. Such cases, although severe, nearly always run a prolonged clinical course.

C. Clinical Varieties of Puerperal Infection

The following clinical varieties of puerperal infection must be considered:

1. Uterine infection { Sapræmia. / Septicæmia.

2. General puerperal peritonitis.
3. Local pelvic inflammation :
   Cellulitis.
   Peritonitis.
   Salpingo-oöphoritis.
   Thrombo-phlebitis.
4. Phlegmasia alba dolens.
5. Pyæmia.

1. Uterine Infection.—From what has been already said in connection with the pathological anatomy of puerperal infection, it will be evident that cases of infection of the uterus may be divided into two classes, corresponding to the two varieties—*putrid* and *septic*—of puerperal endometritis. Upon this basis two clinical types may be distinguished —*saprœmia*, corresponding to putrid endometritis, and *septicœmia*, corresponding to septic endometritis. *Saprœmia* may accordingly be described as a local uterine infection, due in the great majority of instances to saprophytic bacteria, but sometimes to pyogenic organisms ; there is no general dissemination of the organisms, which are limited to the uterine cavity, and the clinical symptoms are produced by the absorption from the uterus of the toxic products of bacterial action. It is therefore a septic toxæmia. *Septicœmia* may be described as a generalised infection due to pyogenic cocci, to the bacterium coli, or to various specific organisms, which enter the body through the genital tract, and become widely disseminated through the lymphatic or vascular system. Technically the diagnosis of septicæmia is made by recognising the infecting organism in the blood stream. In fact, their presence in the blood stream is not constant ; they appear to pass into the blood from the infection-site intermittently and in comparatively small numbers, and they do not long remain there except in the case of infective emboli. In many cases of undoubted septicæmia blood cultures are negative, and Western only succeeded in getting a positive result in 40 per cent. of 100 cases examined. The best time to obtain blood for culture is probably immediately after a rigor or when the temperature is at its highest. The passage of organisms from the uterus into the blood stream is due to an imperfect defensive

barrier, and this affords an easy explanation of the 'borderline' cases in which a differential diagnosis between sapræmia and septicæmia may be very difficult.

It will be remembered, however, that the occurrence of mixed infection is not infrequent, and in such cases the local appearances in the uterus are atypical, and cannot be definitely placed in either class; so also in such cases the clinical features are irregular, and may comprise many of those of both classes. While, therefore, it may be easy to make a diagnosis of *uterine infection*, it is not always possible to carry the diagnosis further than this, and the names 'sapræmia' and 'septicæmia' must accordingly be applied with some caution. In general terms it may be said that sapræmic infection is less severe than septicæmic infection; the resulting illness accordingly is milder, runs a shorter course, and is less likely to be attended by complications.

The Onset of Uterine Infection.—It is in the initial stage that the differential diagnosis of the two varieties is difficult, and it will be best in the first place to consider the general symptoms of the onset of uterine infection without reference to its subdivisions.

The occurrence of evanescent rises of temperature in the puerperium from trivial causes has been already referred to; it will be remembered that in such cases the pyrexia is moderate in degree, is of brief duration, and yields easily to treatment. The possibility of the occurrence of intercurrent febrile affections, unconnected with the puerperal state, is also to be borne in mind. But the general rule which must be rigidly applied, is that every case of 'fever' arising in the puerperium should be regarded as the result of infection unless some other cause for it can be definitely recognised.

The onset of *uterine infection* almost always occurs in the first puerperal week, and, except in rare instances, during the first four to five days. Cases occurring within the first three days are probably due to infection during labour; cases beginning later than this are probably due to infection subsequent to labour. In *mild* cases the onset is characterised by rise of temperature to 101° to 102° F., corresponding, or sometimes exaggerated, rapidity of the pulse, frontal head-

ache, and more or less feeling of general illness or malaise. In *severe* cases the rise of temperature is ushered in or quickly followed by a rigor, the frequency of the pulse is exaggerated, the headache and malaise are more pronounced, and sometimes vomiting occurs. Sapræmia is much more frequently associated with the mild type of onset than with the severe type ; septicæmia may be equally well associated with either. Accordingly, while the mild type of onset is of no value in differential diagnosis, the severe type of onset indicates the probability of the case being one of septicæmia. A case which begins mildly may, however, run a severe and prolonged course.

The condition of the uterus must be carefully observed at the onset of uterine infection. In sapræmia involution is usually delayed or arrested ; in addition, the uterine cavity may contain infected blood-clot or pieces of adherent placenta or membrane. Consequently the uterus is abnormally large for the puerperal date, and also, usually, tender to the touch. In septicæmia, on the other hand, involution is usually unaffected, the uterine cavity is empty, and the size of the uterus corresponds to the puerperal date. Many atypical cases will, however, be met with in which septicæmia is accompanied by sapræmia, and the uterus is too large for the puerperal date.

The lochia frequently become putrescent (offensive) in uterine infection. This is especially likely to occur if the uterine cavity contains blood-clot or placenta, and if saprophytic organisms obtain access to it. It is therefore commonly met with in sapræmia. But the presence of an offensive discharge must not be regarded as indicating anything further than infection ; it does not even follow, necessarily, that the infection is in the uterus. The lochia may decompose at the vulva or in the vaginal canal, while the uterus remains unaffected, and no unfavourable symptoms whatever occur. On the other hand, septicæmia of the greatest severity may occur without any decomposition of the lochia whatever.

From what has just been said, it will be clear that it is often impracticable at the onset of a case of uterine infection to distinguish septicæmia and sapræmia from one another. Time is required in order that the general course of the illness

and the effects of local treatment may be observed. But the treatment of uterine infection, to be efficacious, must be applied without delay, and consequently the onset of the disease must often be treated before a differential diagnosis of the two varieties is practicable. Treatment will be described later on ; in the meantime the general features of simple sapræmia and simple septicæmia may be described, it being continually borne in mind that cases of mixed

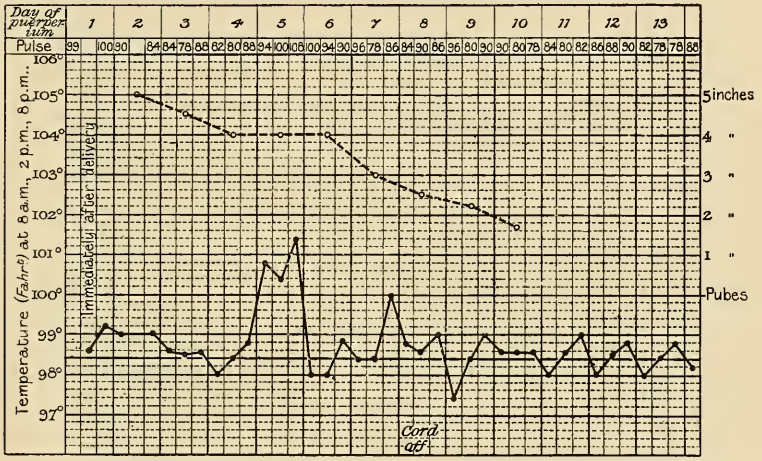


FIG. 271.—Chart of a Slight Case of Sapræmia, showing the Rise of Temperature and Arrest of Involution on the Fourth, Fifth and Sixth Days.

infection which resemble both, and differ from either, are frequently encountered.

Sapræmia.—The three outstanding clinical features of this condition are *pyrexia, decomposition of the lochia,* and *arrest of the process of involution* of the uterus.

The time of onset varies with the date of infection ; if infection has occurred during labour, the symptoms usually appear on the second or third day ; if infection has occurred subsequent to delivery, the symptoms will appear later. As a rule, the first symptom to appear is fever, which may be slight (100° to 102° F.) as in Fig. 271, or severe (102° to 104° F.) as in Fig. 272 ; a slight shivering may accompany the initial rise, but a pronounced rigor is unusual. The pulse-rate rises to an extent proportionate to the tempera-

ture. A certain amount of headache and general malaise are present, but the patient does not appear to be seriously ill. On examination of the abdomen, the uterus will usually be found to be unduly large for the puerperal date ; it is tender to the touch, and softer than normal in consistence. The vulval pads should always be examined, when the fœtor of the lochia, if present, will be perceived, and shreds of tissue may be found upon them. In occasional instances no decomposition of the lochia can be detected ; these cases are probably due to infection by pyogenic cocci, the growth of

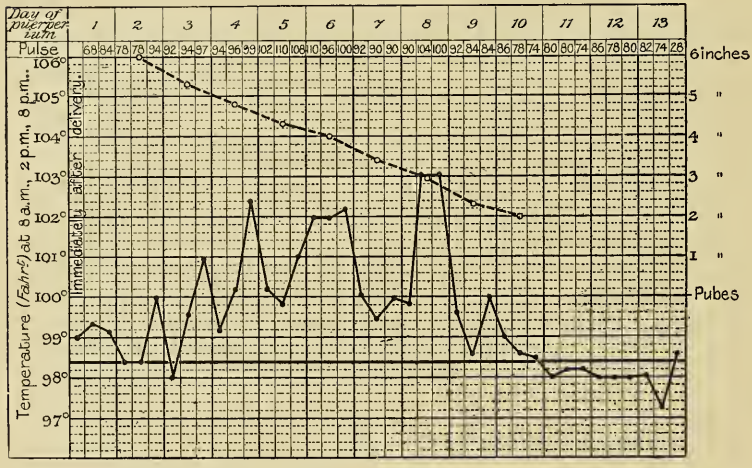


Fig. 272.—Chart of a more Severe Case of Sapræmia which lasted from the Second to the Eighth Day.

which has been limited to the uterine cavity. The amount of the lochia is often profuse, and sometimes an admixture of fresh hæmorrhage may be observed. A mild case of sapræmia when suitably treated can usually be cured in two or three days ; more severe cases may last for a week or upwards before yielding to treatment (Fig. 272). If untreated, the symptoms may increase in severity, and generalised infection—indicated by rigors and great rapidity of the pulse—or local pelvic lesions, will follow—*i.e.*, the case has become one of septicæmia. Very slight cases of sapræmia are often met with in which the only abnormal indications are slight fever (100° to 101° F.) and a little enlargement

without tenderness of the uterus. Or a similar degree of fever may be the result of infection of superficial tears of the vulva, perineum, or vaginal walls. The patient may appear to be perfectly well ; she complains of no headache, and the lochia are healthy. It is possible that such cases are sometimes due to imperfect uterine drainage, resulting perhaps from the recumbent position, or from the presence of an uninfected clot in the uterus, preventing the free escape of the lochia. The result is absorption from the uterus of waste products sufficient slightly to raise the temperature.

Septicæmia.—The symptoms of septicæmia bear a broad resemblance to those of sapræmia just described ; generally speaking, however, they may be said to be of much greater severity, and much less amenable to local treatment. Septicæmia may be produced not only by various organisms, but by various classes of organisms ; the clinical features accordingly show great variations. And further, since organisms exist in nature in various degrees of attenuation, the severity of the symptoms which they produce is variable. An exhaustive description of puerperal septicæmia is accordingly impossible except in a monograph ; its main features can, however, be briefly presented. Our present knowledge does not enable us to recognise, from the clinical features, the organisms by which it is produced in a particular case.

Onset.—The onset is almost always acute, and seldom occurs later than the third day of the puerperium ; it may, however, occur within twenty-four hours after labour, and as a rule it may be said that the earlier the onset the more acute will be the disease. While not invariable, an initial rigor occurs in the majority of cases ; when regular temperature observations have been taken, a certain amount of pyrexia may be found to have preceded it, the temperature rising in steps day by day. Headache and general malaise also sometimes precede it, but often the patient is quite unconscious of illness until the onset of shivering. A severe rigor begins with a sensation of cold so intense as to cause ' chattering ' of the teeth and general muscular tremors ; the skin surface becomes cold to the touch, and from spasm of the erector pilæ muscles assumes the appearance of ' goose-flesh ' ; the face and lips become somewhat blue, and the features contracted. The rectal temperature in a moderately severe

rigor will show a rise to 103° to 105° F., but 106° to 107° is sometimes reached ; the pulse is very rapid, and at the wrist, difficult to count. The shivering stage may be momentary or may last from ten to fifteen minutes ; it is succeeded by a congestive stage in which the sensation of cold gives place to one of burning heat ; muscular tremor ceases, and the face becomes flushed ; the skin feels hot and is at first dry, afterwards moist. Severe headache often accompanies this stage. Then sweating sets in, and the temperature rapidly falls several degrees ; after a rigor of exceptional severity, it may fall to one to two degrees below the normal.

It will be most convenient to consider the general clinical features one by one.

Temperature.—The pyrexia always runs an irregular course, the general type of which is remittent. Repeated rigors may recur at irregular intervals in cases of acute infection ; but no regular variations in the diurnal temperature occur, as, for instance, in typhoid fever ; temperature charts, unless they show at least four-hourly measurements, are therefore quite misleading. There is, as a rule, no apyrexial period, but a remission of two or three degrees normally occurs at some period of each day. In cases of moderate severity the highest diurnal temperature is about 102° or 103° F. ; in severe cases it may be 104° or 105° F. Generally speaking, the pyrexia is higher and shows wider fluctuations than in sapræmia.

While the temperature is, as a rule, a fair index of the severity of the infection, its prognostic importance must not be over-estimated, severe pyrexia and repeated rigors, recurring during several weeks, being not incompatible with recovery. On the other hand, very severe or rapidly fatal cases may occur without very high temperature.

Pulse.—The pulse-rate is always rapid, and is to a great extent independent of the temperature. The pulse may be over 120 with only a moderate degree of fever ; in severe cases it may reach 130 to 140 ; this disproportionate rapidity of the pulse in puerperal illness, in the absence of such complications as heart disease or exophthalmic goitre, is an almost certain indication of septicæmia. Slight diurnal variations follow the fluctuations of temperature. The volume of the pulse is small, and the tension low in severe

cases. The rate and tension of the pulse are of great importance in prognosis ; a persistent pulse-rate of over 120 being of grave significance.

The Pelvic Organs.—In a case of pure septicæmia, the uterine cavity will be found empty, and involution, as a rule, will not be markedly arrested ; there will, therefore, be no undue enlargement or tenderness of the uterus. The lochial discharge usually ceases early in a severe case, and when present may show no sign of decomposition. On vaginal examination no local signs of pelvic inflammation will be found in the early stages, but vulval, vaginal, or cervical lacerations may show signs of local infection.

The Blood in a case of septicæmia contains a small number of the organisms which represent the infective agent. When detected they afford a proof of the septicæmic nature of the infection. In cases of sapræmia the blood is sterile. Intense anæmia is produced by septicæmia when the course of the illness is prolonged, and there are repeated rigors. There is also well-marked leucocytosis, which varies in degree, but may reach 30,000, with 80 to 90 per cent. of polymorphonuclear cells ; the proportion of eosinophile cells is diminished in proportion to the severity of the infection. A high degree of leucocytosis is not of unfavourable significance ; if there is a local focus of infection it may indicate the formation of pus.

The Heart.—Cardiac action is unfavourably affected by degenerative changes in the muscle, but the gravest cardiac complication is ulcerative endocarditis, which may occur either in septicæmia or pyæmia. It is often unrecognised clinically, but may lead to the formation of multiple septic emboli. It is almost always fatal.

Pleurisy, Pneumonia and *Metastatic Pulmonary Abscesses* may occur in septicæmia and pyæmia. Later on, signs of acute *peritonitis,* either pelvic or general, or signs of acute pelvic cellulitis may be found.

Subjects of puerperal sepsis usually take nourishment freely, there is no vomiting, and the digestive processes are good. *Vomiting* when it occurs is of serious import, especially when associated with abdominal distension and rigidity ; after some time the vomit may become black from admixture with blood, even when the case is not complicated by peri-

tonitis. As a rule, persistent vomiting indicates peritonitis, but tympanitic abdominal distension is frequently seen as the result of a general septicæmic infection. *Diarrhœa* is not an infrequent symptom, and may be of service in assisting the excretion of toxins. When uncontrollable or involuntary it is of serious omen. *Sleeplessness*, often accompanied by severe headache, may be met with, and is to be regarded as another unfavourable sign. *Cutaneous rashes*, of erythematous or papular type, are not uncommon ; they are usually transient, and may disappear in one part to reappear in another. Profuse sweating is common, and may lead to an eruption of sudamina. The *urine* is usually scanty, concentrated, and contains a trace of albumen. The *tongue* at first is moist but furred ; as the disease progresses it becomes dry, and in very severe cases brown and cracked, while sordes collect around the teeth. The *intelligence* is usually unimpaired, even in fatal cases, almost up to the moment of death, but delirium passing into coma sometimes supervenes as the end approaches. The *mammary secretion* becomes suppressed in severe cases after the first few days. *Pain* is an infrequent symptom of septicæmia. In the initial stages there may be severe aching pain in the back, limbs, joints and head, but this does not persist. Abdominal pain is rare except when there is a local pelvic lesion or general peritonitis. The *joints* and synovial sheaths sometimes show serous effusions in septicæmia, one after another being implicated, but the effusions are usually re-absorbed without suppuration occurring.

Diagnosis.—Great practical importance is attached to bacteriological examination of the uterine lochia. From what has been already said it will be clear that blood examination for diagnosis is uncertain, as only positive results can be trusted absolutely. For clinical purposes the diagnosis of the infecting organism is better made from the uterine lochia, but very careful technique is required in obtaining the material. Lochial swabs may be taken as follows : the vaginal canal should first be well douched ; a large-size Ferguson's speculum should next be passed so as to expose the portio vaginalis and shut off the vaginal walls ; the surface of the portio vaginalis and the cervical canal should next be carefully cleansed by swabbing ; a short

sterilised glass tube is then passed into the cervix, and a sterile swab then carefully passed, without contact, into the tube and pushed up to the fundus. Swabs of lochia thus taken from the interior of the uterus may yield pure cultures of streptococci or staphylococci ; or mixed growths of these organisms with the bacterium coli and the pneumococcus may be obtained. Bacteriological examination of the vaginal secretion is useless for diagnosis ; it has been sometimes found sterile when the uterine lochia contained pyogenic cocci, but it usually contains pathogenic and non-pathogenic organisms even when the uterus itself is not infected. In clinically severe cases of puerperal septicæmia the streptococcus in pure culture will be found in roughly three-fourths of the cases. In the remainder a staphylococcus in pure culture, the bacterium coli, or a mixture of organisms may be found.

Attempts have recently been made to show that strains of streptococci which are capable of producing septicæmia are characterised by a definite hæmolytic action. Under further experiments, however, this view has broken down, for it has been shown that the same hæmolytic power is possessed by non-virulent strains of streptococci. Hæmolytic action is, therefore, of no diagnostic significance.

It must be borne in mind that a mild fever of either sapræmic or septicæmic type may be caused by infection of wounds of the lower part of the genital tract—cervix, vagina, vulva, and perineum—while the uterus itself remains free from infection. These parts should, accordingly, always be examined, and the condition of wounded surfaces carefully noted.

The distinction between sapræmia and septicæmia may often be made by attention to the condition of the uterus and the lochia, and to the effects of intra-uterine disinfection.

In cases of difficulty it should be the rule to regard as septic in origin all cases of pyrexia in the puerperium for which some other cause cannot be clearly demonstrated. Such disorders as influenza, scarlet fever, and enteric fever may no doubt attack lying-in women and produce a train of symptoms resembling those of septicæmia ; but they must never be loosely diagnosed, although the temptation to do so may sometimes be difficult to resist.

Prognosis.—At the onset of a case of uterine infection the prognosis must always be guarded. If a well-marked improvement follows the local treatment described later on, the prognosis is good, for the infection is then mainly sapræmic. Yet a case which begins as one of sapræmia may later on develop into one of generalised infection. In a case of simple and uncomplicated sapræmia the prognosis is always good and practically all cases end in recovery. In septicæmia the prognosis is much less favourable than in sapræmia, because the infection is more virulent in type, and the general symptoms are more severe.

The course of septicæmia may be greatly prolonged; after considerable improvement has occurred, serious relapses may supervene, and local affections such as phlegmasia or salpingitis may appear. Sometimes the case terminates in pyæmia. A moderate degree of leucocytosis is of good prognosis; a sudden fall is of serious import, and a rapid rise associated with the formation of localised inflammatory effusions usually indicates suppuration. The symptoms of gravest prognostic significance are the following:—

(1) Pulse-rate persistently over 120.
(2) Persistent vomiting and tympanites, with dry brown tongue.
(3) Sleeplessness.
(4) Repeated severe rigors.
(5) Inability to take sufficient nourishment.

Estimates by different observers of the rate of mortality of puerperal septicæmia vary greatly; this is not surprising when the varied degrees of severity which may be met with are borne in mind. Thus Krönig and Whitridge Williams have each reported fifty cases of streptococcic infection with a mortality of only 4 per cent. On the other hand, a series of one hundred cases of streptococcic infection collected from various sources by the American Gynæcological Society yielded a mortality of nearly 30 per cent. Lea states the general mortality, including mild cases, to be about 10 per cent., but in severe cases it is probably as high as 65 to 70 per cent. The prompt recognition of the condition, and the prompt adoption of suitable treatment, will always favourably influence the patient's chances of recovery.

Treatment.—The importance of the *prophylaxis* of puerperal infection by strict antiseptic routine, by avoidance of unnecessary examinations or operative interference, and by the careful and proper management of the third stage of labour, has been already frequently insisted upon. When once the disease has manifested itself, treatment must be promptly applied, for like most wound-infections, only in the earliest stages can its spread be controlled. Inasmuch as the differential diagnosis of sapræmia and septicæmia can seldom be made immediately, the initial treatment must follow the same general principles for all cases, and will depend upon the severity of the symptoms rather than the nature of the infection.

Mild Type.—Temperature 101° to 102° F. ; no shivering or rigor ; headache slight ; uterus large ; lochia often but not always offensive. Such cases are probably sapræmic, and the dose of toxins absorbed into the general circulation is small. They can usually be cured by hot vaginal douching with a mild antiseptic (lysol, a teaspoonful to a pint), ergot in full doses (ergotin, 3 grains three times a day), and free purgation. Douching and the administration of ergot, by stimulating the uterine muscle, promote drainage and assist the expulsion of retained dead tissues ; purgation assists the elimination of the absorbed toxins. Uterine drainage is assisted by keeping the patient in a sitting position as much as possible. In two or three days the symptoms will subside.

Severe Type.—Temperature 103° F. or higher with or without a rigor ; pulse 100 to 120 ; headache and general malaise well marked ; condition of lochia unimportant, but may be scanty and inoffensive, or profuse and fœtid. In all such cases it is best to begin the treatment by careful and thorough disinfection of the uterine cavity. It will be remembered that in sapræmia the chief focus of infection is the wall of the uterus, which shows the changes described as *putrid endometritis*. This can only be adequately dealt with by clearing all *débris* out of the uterus, and thoroughly douching the uterine cavity with a large quantity of a suitable antiseptic solution.

In clearing out the uterus, an anæsthetic, although not always necessary, is desirable, because it allows of the opera-

tion being more thoroughly performed. The patient should be placed in the modified lithotomy position, and the operator should protect his own hands from infection by wearing sterilised rubber gloves. A swab for bacteriological diagnosis should be first taken in the manner already described. Mechanical dilatation of the cervix is never required during the first week of the puerperium. After thoroughly douching and swabbing the vulva and vagina, one or two fingers can be passed directly into the uterus, and the walls carefully scraped with the protected finger-tip until all *débris* has been removed. Pieces of adherent membrane or placenta may be encountered, the separation of which will cause fairly free bleeding. A blunt wire curette (Fig. 273) may be used for scraping the walls, but the ordinary sharp curette should not be employed during the first week of the puerperium ; this instrument removes too much of the soft

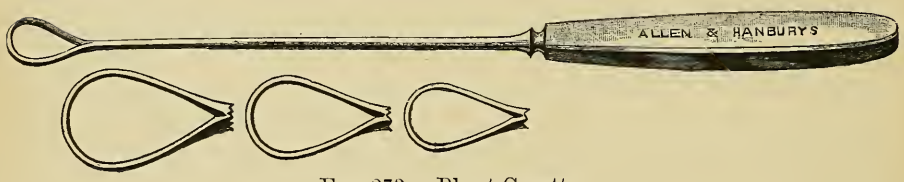


Fig. 273.—Blunt Curette.

uterine wall, destroys the protective leucocytic zone, and opens up fresh channels through which generalised infection may occur. It may also very easily perforate the uterine wall. It is of little use to douche the uterus without first clearing the walls in this way, for douching alone will not detach adherent fragments of placenta or membrane.

The uterine cavity should then be douched with 3 or 4 pints of a hot antiseptic solution (115° F.). Solutions in common use for this purpose are lysol, izal, cyllin (ʒss to Oj), or tincture of iodine (ʒj to Oj), or carbolic acid (1 in 60), or biniodide or perchloride of mercury (1 in 4,000) ; if the latter is employed a quart of normal, sterile, saline solution, or plain boiled water, should be used immediately afterwards to wash out any excess of the mercurial solution which might otherwise remain in the uterus, and become absorbed. If this precaution is adopted there is no risk of mercurial poisoning. Probably the most useful of all

solutions for intra-uterine douching in sepsis is a dilute solution of peroxide of hydrogen (about 5 volumes). This is absolutely non-toxic, and its deodorant power is much greater than that of the usual antiseptics, while its bactericidal strength is at any rate equal to them. It is unnecessary to douche the uterus frequently, all that is practicable will be accomplished by a single douching if the uterine cavity has first been cleared out. The action of the intra-uterine douche is chiefly mechanical, its bactericidal powers being probably very small. In douching the uterine cavity a long glass nozzle with a grooved return channel, such as that shown in Fig. 274, should be employed, or one of pewter, which is unbreakable and can be bent to any required shape, may be

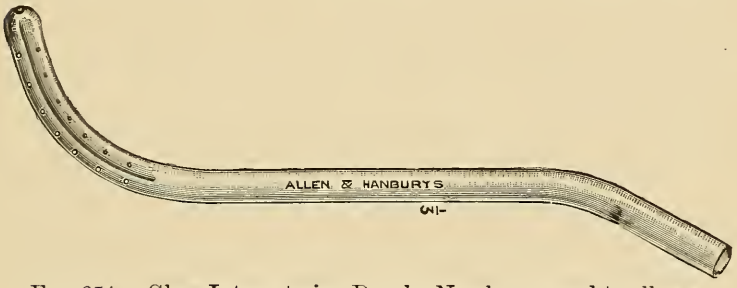


Fig. 274.—Glass Intra-uterine Douche Nozzle, grooved to allow a return flow.

preferred ; it can be sterilised by boiling. Care should be taken to maintain full uterine retraction afterwards by the administration of ergot in full doses ; retention of clot from the oozing surfaces will thus be prevented.

Before exploring the uterine cavity, lacerations of the lower part of the genital tract should be looked for and their condition carefully noted. They will usually be found unhealthy, with more or less sloughing ; they should be carefully cleansed by swabbing, and then freely painted with pure carbolic acid.

If the case is one of simple sapræmia, this treatment, combined with the administration of purgatives, in most cases rapidly cures the patient. Temperature and pulse fall to normal in two or three days, or even sooner, as the toxins are eliminated ; reduction in size of the uterus takes place ; the lochia become once more odourless and usually

very scanty in amount. No further local treatment is then required except that the vagina should be douched twice daily for several days. Complete failure of this treatment indicates that generalisation of the septic process has occurred. Occasionally cases are met with in which considerable-sized pieces of putrid placental tissue are found in the uterus, associated with severe symptoms of infection. The removal of such placental remains by mechanical means is often accompanied by severe bleeding and followed by great exacerbation of the symptoms, the explanation being that laceration of vessels allows of the rapid entrance into the circulation of large doses of toxic materials, and of the general dissemination of organisms by the blood stream. Accordingly, some teachers advise that such cases should not be dealt with by operative measures at all, but the spontaneous separation of the placental tissues should be awaited, loose pieces being removed by irrigation. Frequently, however, severe recurrent attacks of bleeding occur in such cases, and the removal of the placental remains is the wiser course in all cases. The operator should use blunt instruments only, and freely douche the uterus afterwards. A septic uterus should of course never be packed, neither should strong antiseptics capable of exerting a caustic action on the uterine wall be employed. Such an effect reduces the vitality of the uterine tissues, and diminishes their power of resisting the spread of the infection.

When it appears probable that the case is one of septicæmia, three lines of treatment are available—viz., (a) *specific*, (b) *general*, and (c) *surgical*.

(a) *Specific Treatment*.—The specific treatment of an infective process consists in an attempt to establish artificially a condition of immunisation against the particular infective agent present. Immunity is attained by the introduction of certain organic substances which are antagonistic or antidotal to the infective bacteria themselves, or to the toxins which they produce. This imitates the natural processes, in which spontaneous recovery from an infection is the result of the destruction of the infective organisms and their toxins by ' anti-bodies ' produced by the tissues of the host. The condition of immunity thus produced may be maintained for more or less prolonged periods, and this

will enable the body to resist successfully any fresh infection of the same nature. The process of artificial immunisation may be attempted in one of two ways : (1) Fully formed anti-bodies may be introduced derived from the blood of an animal which has just recovered from the same infection and is therefore immune ; the various *antitoxic sera* are of this nature. Most of them act by destroying the bacteria themselves which are growing in the tissues of the body ; others act by destroying or neutralising the toxins which these organisms have produced. (2) An artificial pure culture may be made of the infective organisms obtained from the fluids of the patient. From the artificial culture thus obtained a *standardised* emulsion is prepared containing a known number of bacteria per cubic centimetre ; the organisms are then destroyed by heat, the emulsion being thus rendered sterile. The injection of these dead bacteria into the tissues of the host stimulates the natural production of certain protective materials in the blood (opsonins), and thus increases the power of the body to overcome the infective process. All *vaccines* are of this description.

Antitoxic sera can at present be obtained for streptococcic, staphylococcic, and bacillus coli infections or for combinations of these organisms ; for the numerous other organisms which may be concerned in producing puerperal infection physiological antidotes are not available, with the exception of the diphtheritic and the typhoid bacilli. It is generally believed that streptococci are the most virulent of the pyogenic cocci, and antistreptococcic serum has accordingly been freely used in puerperal septicæmia, even when a bacteriological diagnosis has not been made. The results of its use have been, on the whole, unsatisfactory. This is probably to be attributed in part to the fact that streptococci are not always the infecting organisms, and in part to the fact that there are many different sub-species of streptococci, each requiring its own antitoxin ; it is therefore difficult to prepare a serum which will efficiently antagonise the species which may chance to be present in any particular case. An attempt to do so has been made in the preparation of the *polyvalent serum*, which is obtained from an admixture of various species of streptococci. In applying this treatment, exact bacteriological diagnosis is obviously of great

importance. In the rare cases which appear to be due to the diphtheria or typhoid bacilli, the special sera of these organisms may be administered.

Antistreptococcic serum should be given by subcutaneous injection in the abdominal wall or the thigh. The glass syringe used should be carefully boiled, and the strictest antiseptic precautions employed in regard to the preparation of the skin, etc. The first dose administered should be at least 15 cubic centimetres, which may be repeated every twelve hours for several days; larger doses have been frequently given without ill-effects. Improvement is indicated by fall of temperature and pulse, cleaning of the tongue, and amelioration of the general symptoms. If no improvement follows, it is useless to persist. Its injection in similar dose into foci of infection, such as pelvic inflammatory effusions, has also been recommended.

Vaccine Treatment is not so simple, and appears to require more exact observation than serum treatment. According to Sir Almroth Wright, estimation of the *opsonic index*, *i.e.*, the proportion of the protective substances present, should be carried out at regular intervals during this treatment. This is not, however, regarded as necessary by all bacteriologists. The vaccine is supplied in sealed glass capsules, each containing a certain number (estimated) of bacteria. It should be given with the same strict antiseptic precautions as the serum. The initial dose should be a small one in a case of puerperal septicæmia, *e.g.* 5,000,000; this dose may be repeated at intervals of three or four days and gradually increased up to 30,000,000 or 40,000,000 if improvement follows and the reaction is not too marked. The preparation of a vaccine requires an expert bacteriologist, and as it involves considerable expense it is at present only available under very restricted conditions.

Results of Specific Treatment.—Antitoxic sera have now been freely used for several years, and it must be admitted that the results are disappointing. While no harm appears to follow, it cannot be said that these remedies have been shown to exert a decided influence in diminishing either the length or the severity of the infective process. Very favourable results have recently been reported by treatment with an autogenous vaccine obtained from cultures of the uterine

lochia in a series of ninety-six cases by Western. Further observations are, however, required before the question can be regarded as definitely settled. It seems desirable, however, to make use of both vaccines and antitoxins when possible in all severe cases, exact bacteriological diagnosis of the nature of the infection having been first made.

(b) *General Treatment.—Food* should be mostly fluid, and milk naturally forms the most important item; 3 to 4 pints are often readily taken even by patients who are seriously ill. Meat extracts, soups and jellies may be added. Alcohol is not required in mild cases and is undesirable in large doses owing to its depressant action on the heart. In small doses it does good when there is difficulty in getting the patient to take sufficient nourishment. If the bowels are constipated a mild aperient should be given every other night; moderate diarrhœa may be allowed to continue unchecked; severe diarrhœa should be controlled by administering starch and opium enemata. *Pyrexia* should not be directly treated unless the temperature rises over 104° F. Antipyretics should not be given, but the use of the wet pack or tepid sponging may be relied upon when necessary. *Sleeplessness* when present should be controlled by hypnotics, such as veronal or sulphonal in doses of 7 to 10 grains, which may be given every night for a time if required. *Subcutaneous saline transfusion* stimulates leucocytosis and phagocytosis, and promotes elimination by the skin and kidneys. It may therefore be employed with advantage in the acute stages, a pint of fluid being introduced twice a day for several days; or a graduated continuous rectal injection may be used for several hours a day.

(c) *Surgical Treatment.*—Attempts have been made in recent years to show that removal of the uterus is capable of favourably influencing the course of severe cases of puerperal septicæmia. Advocates of this operation contend that as the uterus is the chief, if not the sole, focus of infection, its removal will arrest the continuous passage into the circulation of fresh organisms and toxins, produced by the active bacterial development proceeding in it. It is, however, certain that in severe cases of septicæmia widespread dissemination of organisms which multiply in the lymph or blood streams has already occurred; removal of the uterus

under such circumstances cannot arrest, although it may modify, the general infective process, and therefore is not to be regarded as a radical operation. The latter view is upheld by the unfavourable results of this operation, for up to the present it has not been shown to increase the patient's chances of recovery. In the absence of local pelvic lesions this operation should not be performed, but when an infected fibroid tumour is present, when the uterus has been ruptured or perforated, or when there is evidence of abscess formation in the uterine wall, the removal of the uterus may be necessary.

2. **General Puerperal Peritonitis.**—The results of post-mortem examinations show that this condition is infrequent. Some of the symptoms of general peritonitis—*e.g.*, continuous vomiting, meteorism, irregular pyrexia, and a rapid small pulse—are met with in puerperal septicæmia. The clinical diagnosis of general peritonitis may accordingly present unusual difficulties in cases of puerperal infection. A systematic description of the clinical features of this affection is unnecessary in a text-book of midwifery, for it differs little from general peritonitis due to surgical causes, the distinctive symptoms being abdominal pain and rapidly increasing distension accompanied by nausea and vomiting, the latter sometimes persistent. The prognosis is very serious, but free drainage, suprapubic, vaginal, and lumbar, should be established as soon as the diagnosis is made, and the same general and specific treatment applied as in cases of septicæmia.

3. **Local Pelvic Inflammation.**—A well-defined group of cases of puerperal infection may be recognised, of which the main feature is the presence of pelvic inflammatory lesions—*i.e.*, of course, lesions outside the uterus. In such cases the inflammatory process is seldom limited to a single tissue or a single organ, yet it ordinarily manifests itself chiefly in either the *pelvic peritoneum*, the *pelvic cellular tissue*, or the *uterine appendages*. Thus, with pelvic cellulitis more or less peritonitis is usually found as an accompaniment, while with pelvic peritonitis the Fallopian tubes and ovaries are necessarily implicated to a greater or less extent. The relative frequency of occurrence of this group of local puerperal infections is probably not more than 1 in 10 of all

cases. The original focus of infection is, in almost all cases, the uterus ; thence the process spreads by direct continuity through the Fallopian tubes to the pelvic peritoneum, or through a cervical tear to the cellular tissue ; or it may spread through the lymphatics of the uninjured cervix to the cellular tissue ; or through the lymphatics of the uterine wall to the peritoneum. Occasionally the veins appear to be the chief channels of infection, and a spreading phlebitis occurs which may pass downwards to the femoral vein, or upwards to the inferior vena cava. The comparative rarity with which localised pelvic inflammation follows uterine infection is probably due, in some way, to the protection afforded by the zone of leucocytic activity in the affected uterine wall (see p. 573).

Common Features.—Cases of puerperal pelvic inflammation are probably due to pyogenic organisms of somewhat attenuated virulence, or to auto-infection by the diplococcus gonorrhœæ ; sometimes also to bowel infection by the bacillus coli communis. It is usually stated that they are characterised by a late onset, but this is not strictly accurate. Severe symptoms do not as a rule appear earlier than the latter half of the first week—*i.e.*, about the fifth or sixth day, but slight symptoms of uterine infection, often overlooked, are almost always present earlier than this. When such symptoms as moderate elevation of temperature and decomposition of the lochia are disregarded, the real onset of the disease is naturally misunderstood. It is quite possible that if due heed were paid to the significance of these symptoms in such cases, the appearance of the local inflammation might be altogether prevented by early and appropriate treatment. A rigor often occurs, and pelvic pain, practically unknown in sapræmia and septicæmia, is a prominent symptom of the onset of some of these affections. Their general course is prolonged, localised suppuration is not uncommon, but a fatal termination is rare. Mild cases, not marked by an acute onset, are probably of frequent occurrence, and, being overlooked or inadequately treated, pass into the phase of *chronic pelvic inflammation* so often met with in parous women of all classes of life.

Pelvic Cellulitis (synonyms : Parametritis, Broad-ligament Phlegmon).—Systematic descriptions of this affection

are usually given in text-books of gynæcology ; a few points only require notice in the present connection.

An extensive cellulitic effusion forms a hard immovable, non-tender swelling which may fill the entire pelvis and surround the uterus ; or may be limited to, or chiefly apparent in, one or other broad ligament. In the former case the position of the uterus is unaltered ; in the latter the uterus is displaced to the unaffected side. In the early stages when the amount of effusion is small, the swelling, being lateral in position and not immovable, is difficult to distinguish from an inflamed tube and ovary. After a few days the characteristic spread of a cellulitic effusion clears up the diagnosis. Spreading along the cellular tissue planes the effusion may pass upwards to the iliac fossa and the abdominal wall, forming a swelling palpable by abdominal examination above the inner half of Poupart's ligament, or may track upwards along the ilio-psoas muscle to the region of the kidney.

In some cases a small effusion only is formed, which occurs clinically as an ill-defined, firm swelling, placed laterally to the uterus, and showing a limited amount of mobility ; this usually subsides in from one to two weeks ; a more extensive swelling usually persists for several weeks, but even those of large size as a rule ultimately become absorbed. Sometimes suppuration occurs, indicated by sharp irregular rises of temperature, rigors, exacerbation of pain, and marked increase in the degree of leucocytosis—always present in pelvic inflammation. Cellulitic abscesses usually point either above Poupart's ligament, or in one or other lateral vaginal fornix ; more rarely they rupture into the rectum or bladder. Occasionally they pass out of the pelvic cavity through the sciatic or obturator foramen, to appear on the buttock or the anterior aspect of the thigh. In rare cases of extensive effusion absorption takes place around the uterus, leaving the pelvis practically free, while outlying parts of the effusion persist and ultimately suppurate, forming abscesses in such situations as the iliac fossa or near the kidney. This condition has been named *remote parametritis*.

Pelvic Peritonitis (*Perimetritis*) *and Salpingo-oöphoritis.*—A *peritonitic* pelvic effusion usually occupies the pouch of

Douglas ; it therefore forms a swelling behind the uterus, and when of large size it displaces this organ forwards. It is of softer consistence than a cellulitic effusion, and much more tender to touch. A roof of matted tissues, comprising omentum and large or small bowel, is formed above it ; this roof may be recognisable as an abdominal swelling occupying the hypogastrium, tender to touch, ill-defined in outline, and sub-resonant on percussion. These effusions rarely suppurate; when suppuration does occur the resulting abscess may be spontaneously evacuated either into the vagina, the rectum, or some other part of the bowel. Spontaneous absorption without formation of pus occurs in the majority of cases, and is usually more rapid than in the case of cellulitis.

Acute tubal or *ovarian inflammation*, leading to the rapid formation of a pyosalpinx or an ovarian abscess, is rarely met with in the puerperium. Chronic inflammatory affections of these organs, insidious in onset, and not leading immediately to acute symptoms, are, however, not uncommon sequels of puerperal infection ; they are usually overlooked until the appearance of some complication, or the chronic ill-health of the patient, leads her to seek advice.

Cystitis may occur in the puerperium from use of the catheter, or more rarely from spontaneous ascending infection *per urethram*, but it does not differ from the same condition as met with under other circumstances.

Thrombo-phlebitis.—The occurrence of septic phlebitis accompanied by thrombosis in the deep uterine veins in septic conditions has been already mentioned. This process may spread by continuity along the ovarian veins or into the iliac, or femoral veins, and in severe cases may ascend into the inferior vena cava. This change plays an important part in the production of pyæmia, and when localised in the femoral or external iliac vein it produces one form of phlegmasia dolens. *Acute* cases of pelvic thrombo-phlebitis are characterised clinically by the occurrence of repeated and severe rigors ; in many *mild* cases, only slight rise of temperature and quickening of pulse result from it. Sometimes veins in distant parts, and especially the lower limbs, become thus affected during the puerperium, especially if varicose conditions are present. There is little doubt that they are due to a mild form of infection.

The treatment of pelvic phlebitis is that of septic infection generally ; when affecting the lower limb it should be immobilised by bandaging it lightly to a pillow, and hot fomentations applied over the affected vein until the pain and tenderness disappear. The limb must be kept at rest until the intravenous clot is firmly organised.

Treatment of Local Pelvic Inflammations.—The general and specific treatment of septicæmia already described is applicable to these cases also. Disinfection of the uterine cavity should be practised promptly upon the appearance of acute local symptoms, and before the pelvic inflammatory effusions have had time to become extensive. At periods later than this intra-uterine treatment is of little use. Prolonged confinement to bed, with careful feeding and nursing, and attention to the daily evacuation of the bowels, will in most cases lead to the absorption of the effusion. Collections of pus should be evacuated without delay, the incision being made in the position indicated by softening ; but the diagnosis of suppuration is sometimes difficult, for the abscess may form in a position inaccessible to clinical examination. Incisions into cellulitic areas should not be made until the local signs of suppuration appear. Careful and repeated estimation of the number of leucocytes in the blood may be of great assistance in diagnosis ; when the number present is 25,000 per cubic centimetre or over, with a high percentage of eosinophile cells, the presence of pus is highly probable.

4. **Phlegmasia alba dolens (White Leg).**—This condition when well marked consists in a general swelling of the affected limb from the foot to the groin, its onset being attended by severe pain, pyrexia, and general malaise. Although in the great majority of cases it affects the lower limbs only, in a few rare cases an upper limb has been simultaneously or subsequently attacked. Two varieties, the *thrombotic* and *lymphatic*, may be distinguished.

Thrombotic Form.—In this, the most frequent form, the immediate cause of the swelling is phlebitis of the external iliac or femoral vein, leading to thrombosis, and obstruction to the venous return from the limb. In the upper part of Scarpa's triangle the thrombosed vein can be readily felt as a firm, somewhat nodular and tender, thick cord. The swelling of the limb is due to rapidly developing œdema, which

appears first in the foot and quickly extends to the thigh ; the swollen parts are soft and pit on pressure, and are at first of a dusky blue rather than a white colour. Usually the femoral vein is involved by continuous spread from similarly affected uterine or pelvic veins ; sometimes, however, no evidence of pelvic phlebitis can be obtained clinically. But the condition is almost certainly septic in all cases, and streptococci have been found in the femoral clot by Widal. Probably these organisms, circulating in the blood stream, may set up phlebitis in a remote part, by attacking the endothelium of the vein-wall. Slight cases of this variety, in which only the foot and leg are affected, are not uncommon.

Lymphatic Form.—In some cases no signs of femoral thrombosis can be found ; the swollen limb has a tense, white, glistening appearance, and does not pit on pressure ; there may be enlarged and tender lymphatic glands felt in the groin. In the early stages the skin shows a slight flush, and later on, small areas of dermatitis or superficial gangrene may appear. It is stated that in such cases the effused fluid in the limb is not serum (as in œdema), but coagulable lymph. It is much rarer than the thrombotic form, and is probably due to lymphatic infection setting up a deep cellulitis in the affected limb. It is, of course, septic in nature.

It is not at all infrequent for cases to be met with in which both factors, thrombosis and lymphatic infection, occur, giving rise to swelling of atypical characters.

Although sepsis must be regarded as the essential cause of phlegmasia, certain contributory causes must also be recognised ; of these the most important is hæmorrhage during or after labour ; others are multiparity and general ill-health, especially blood diseases. The frequency of phlegmasia has greatly diminished since the general adoption of antiseptic principles in the practice of midwifery.

Clinical Features.—A more or less acute onset is characteristic of this affection. It occurs in the great majority of cases in the latter half of the second week of the puerperium (tenth to fourteenth day), although it may appear as early as the sixth or as late as the thirtieth day. Acute pain is felt in the affected limb, and the temperature may rise rapidly to 102° or 104° F. ; slight shivering or sometimes a well-marked

rigor may accompany these symptoms. There has often been a certain amount of pyrexia during the first puerperal week, as is the case with the local pelvic inflammations—*i.e.* asepsis has not been successfully maintained (Fig. 275). The acute pain and the fever last from three or four days in a mild case; to ten or twelve days in a severe one ; then both subside concurrently. In the thrombotic form, tenderness and induration will be found along the line of the femoral vein. The affected limb is immobile as if from paralysis, and frequently the presence of fluid can be detected in the knee-joint. The temperature of the affected limb is about half a degree higher than that of the sound one. The left leg is much more commonly affected than the right ; this is no doubt due to the preponderating frequency of the first position of the vertex, which makes cervical laceration much more common on the left than on the right side, and predisposes to infection of the left broad ligament, its vessels and lymphatics. Both limbs are affected in about one-third of the cases, but almost always consecutively after an interval of one or two weeks, a simultaneous onset of the disease in both limbs being extremely rare. From recent statistics it appears that phlegmasia occurs about once in four hundred cases of labour. Cases in which the upper limb becomes affected are very uncommon.

Treatment.—Treatment should be chiefly directed to the immobilisation of the affected limb, and the relief of the local pain. Almost the only risk attending the disease is pulmonary embolism from detachment of a portion of blood-clot from the thrombosed vein. To prevent the occurrence of this accident the limb should be slung in a cradle, or laid upon pillows and immobilised by placing heavy sandbags in contact with it on either side, from the hip down to the foot. Voluntary movement must not be allowed for fourteen days after the cessation of pain and all febrile symptoms. Many weeks or even months may elapse before all the swelling has disappeared from the limb, and a certain amount of pain and stiffness on movement may persist for even longer periods. Pain is best relieved by the application of moist heat, in the form of hot fomentations, or by freely painting the line of the vein with tincture of belladonna. After the pain has disappeared the limb must be kept carefully

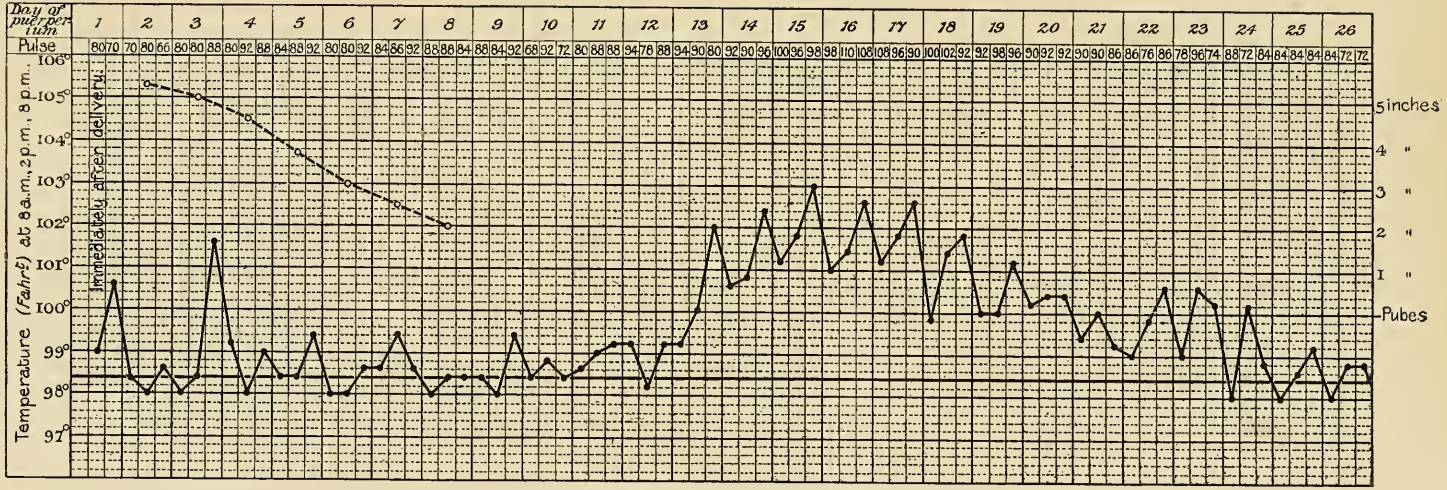


FIG. 275.—Chart of a Case of Phlegmasia Dolens, showing the Onset and the Period of Pyrexia.

wrapped up in cotton wool, and shielded from pressure with a 'cage.' In cases of unusually acute onset attended with a rigor, antistreptococcic serum may be employed. The administration of citric acid in ten-grain doses three times daily is believed to retard the spread of the clot by diminishing the coagulability of the blood. Massage is useful in the later stages when pain and swelling persist.

Pyæmia is a form of septicæmic infection characterised by extensive thrombo-phlebitis in the pelvic veins, leading to the formation of multiple infective emboli, from which secondary infective foci may be carried to the heart, the lungs, the abdominal viscera, the joints, the synovial membranes, etc. The emboli may consist of minute portions of infected clot which have become detached, or of aggregations of bacteria. The organisms concerned are those which may also be met with in septicæmia. In all probability they are of somewhat attenuated virulence, as pyæmia is somewhat later in its appearance, and also runs a more protracted course, than septicæmia.

The thrombo-phlebitic changes begin in the uterine or ovarian veins, whence they spread to the external and internal iliac veins, and ultimately to the inferior vena cava ; in the case of the ovarian veins the infection spreads directly to the renal vein on the left, the inferior vena cava on the right. The uterine and iliac veins are found affected at autopsies much more frequently than the ovarian veins.

The embolic complications which may occur in the course of pyæmia lead to such varied conditions as ulcerative endocarditis, multiple pulmonary abscesses, hepatic and splenic abscesses, pyelitis, and joint effusions, either serous or suppurative.

The records of autopsies on women who have died from puerperal septic diseases appear to show that this form of sepsis is frequent, for thrombo-phlebitic changes are evident in from 30 to 50 per cent. of such cases (Lea).

Treatment.—The specific and general treatment already described for cases of septicæmia are to be made use of in pyæmia also. Within recent years an attempt has been made to limit the spread of venous infection by surgical means.

Ligature or Excision of Pelvic Veins.—During the last

eight or nine years certain cases of pyæmia associated with pelvic thrombo-phlebitis have been treated by this procedure which is based upon the operation of excision of the external jugular vein for aural pyæmia. The operation is naturally severe, and cannot be undertaken with any hope of success except in the early stages, while the general condition of the patient is good and there are no signs of the formation of embolic metastases. If there is marked œdema of the lower extremity, the thrombosis is probably too extensive to be controlled by these operations. The vessels may be exposed either by an extra-peritoneal or an intra-peritoneal incision, the latter being preferred, as the affected vessels cannot be sufficiently exposed by the former. Further, thrombotic changes may be found in the vessels of both sides, and free access to the whole of the pelvis is then required.

A practical difficulty in the application of this operation is the question of diagnosis. Recognition of thrombo-phlebitic changes in the pelvis by vaginal examination is by no means certain, and these changes are not invariably found in cases which are clinically pyæmic. And further, it is not practicable in all cases to tie off or remove the affected veins owing to the extent of vessel involved ; yet the extent of the lesion cannot be gauged without exposing the veins affected.

It is impossible in the meantime to estimate the value of this operation ; of some fifty to sixty recorded cases the mortality has been 40 per cent. (Lea), but it must be assumed that many of these were acute cases in which recovery was hardly to be expected. Further experience is necessary before it can be decided whether or not this operation will prove to be of real value.

Inflammation of the Mammary Glands (Mastitis, Mammary Abscess)

Unless proper precautions are observed during the process of suckling, the mammæ may become infected by various pathogenic and pyogenic organisms which gain access to it usually through superficial skin-cracks, or sometimes, possibly, through the ducts which open upon the nipple.

Bacteriological observations show that bacteria are present in human milk in 86 per cent. of pregnant and 91 per cent. of lying-in women. Some bacteriologists have stated that staphylococci can often be found in the milk-ducts of healthy nursing women when the glands appear to be normal. It seems probable, therefore, that the importance assigned by clinical observations to nipple-cracks in the production of mastitis has not been over-estimated ; for if these organisms may occur in the milk-ducts without causing inflammation, it must be their entrance into the lymphatics through a wound of the surface which sets up the process. The physiological engorgement of the breast at the beginning of lactation, which reaches its height on the fourth day, does not lead to mastitis unless infection also occurs through one of the channels just indicated. The inflammation may occur (1) in the subcutaneous cellular tissue—usually under or near the areola (*pre-mammary abscess*) ; (2) in the substance of the gland (*intra-mammary abscess*) ; (3) in the sub-glandular connective tissue (*retro-mammary abscess*) ; the last-named variety seldom follows infection through the nipple, but usually results from empyæma, or disease of the ribs. The foci of infection are often multiple ; suppuration frequently but not invariably occurs, and abscesses sometimes form in more than one, or even in all three, of the localities just indicated. Mastitis may occur during pregnancy, but this is rare ; in the puerperium it most commonly occurs during the first two or three weeks, but may be met with much later than this.

The onset of mastitis is attended with diffused redness and severe pain in the affected gland, a rapid rise of temperature, headache, and other signs of general malaise ; then a firm and very tender swelling appears at some part of the gland. Suppuration may be attended by rigors, and the usual local signs—softening of the inflamed area, with œdema of the skin, or redness and tension if the abscess is superficial. A *pre-mammary* abscess sometimes opens spontaneously upon the surface or into a large milk duct, leading to the discharge of pus through the nipple. Sometimes both glands are affected, but seldom simultaneously, the second probably becoming directly infected from the first through suckling or through lack of surgical cleanliness.

Treatment.—The *prophylaxis* of mammary inflammation consists in the proper management of the breasts during pregnancy and suckling, which has been already described. When nipple-cracks are promptly and thoroughly treated, mastitis very seldom ensues. If, owing to the death of the child or for any other reason, the mother does not suckle, the nipples should be carefully disinfected in the manner described on p. 561, and the breasts protected by cotton-wool and tightly bandaged. If they become very painful, the bandage may be removed and an evaporating lotion (*e.g.* eau de Cologne and water) employed for a few hours, and the bandage then re-applied. A saline or other aperient should be given daily for the first two or three days. Continuous pressure with the aid of free purgation will, as a rule, quickly arrest the activity of the glands. The local application of tincture of belladonna and the administration of potassium iodide are seldom required, but may be resorted to if difficulty is experienced in arresting the secretion.

The first signs of inflammation in the breasts should at once be met by the following measures : (1) cessation of suckling from the affected gland, the secretion being drawn off as required with a breast-pump ; (2) the local application of moist heat (hot fomentations), or preferably of cold by the use of Leiter's coils, through which a stream of iced water can be run ; (3) purgation. If the breast is extensively affected, or if signs of suppuration occur, suckling must be entirely suspended, and the unaffected gland tightly bandaged under cotton-wool to secure even pressure. Suckling from a suppurating breast must be strictly forbidden, for the milk is probably always infected. Suppurating areas must be promptly laid open when recognised. The incisions should, as far as possible, be made parallel to the course of the large milk-ducts which converge upon the nipple. The abscess cavity is frequently multilocular and of irregular shape ; septa must be broken down with the finger to ensure efficient drainage of all parts of the cavity, and a counter-opening at some dependent part may be required. Rubber tubes should be used for the first few days and the cavity washed out daily with an antiseptic solution—*e.g.* carbolic-acid lotion 1-60. Tonics such as iron and quinine are always indicated during convalescence, which may be prolonged when the general

health is unsatisfactory. The functional adequacy of the gland in a subsequent pregnancy as a rule is not affected, for the amount of gland tissue destroyed by suppuration is usually small. Sometimes, however, the gland is so disorganised by multiple foci of suppuration that its removal becomes necessary.

Puerperal Hæmorrhage : Secondary Post-partum Hæmorrhage

Hæmorrhage may occur at almost any period of the puerperium, and may be due to a variety of different conditions. In *slight cases* it takes the form of an undue amount of bleeding during the first three days, undue prolongation of the hæmorrhagic stage of the lochia, or recurrence of bleeding after the lochia have become serous. Such cases may be due (*a*) to retention in the uterus of a small portion of placenta or chorion, or blood-clot, which may or may not become infected ; (*b*) to delayed involution caused by not suckling, or by general ill-health ; (*c*) to uterine congestion caused by cardiac or hepatic disease, by backward displacement of the uterus, by getting up too soon, or by constipation.

In *severe cases* a sudden severe hæmorrhage may occur, or there may be continuous bleeding of moderate but not alarming extent, or irregular profuse losses of blood. Such cases are due to (*a*) sudden relaxation of the uterus in the first few days of the puerperium from nervous shock ; (*b*) to the *separation* of retained pieces of placenta of considerable size, especially if they become infected ; (*c*) to the formation of a placental polypus ; (*d*) to puerperal inversion of the uterus ; (*e*) to the presence of new growths in the uterus—*e.g.* a fibroid which has become infected, or is being extruded into the uterine cavity, carcinoma of the cervix, or lastly chorionepithelioma (deciduoma malignum).

Severe bleeding may occur in the second or third weeks of the puerperium from the separation of a piece of placental tissue. Occasionally cases, almost equally severe, occur in which there is no evidence of placental retention, and in which no other local cause for the hæmorrhage can be found. In these cases there is probably a deficiency both of throm-

botic closure of the utero-placental vessels, and of retraction of the uterine muscle. Cases due to either of the two first-mentioned causes are to be treated in the same manner as cases of primary post-partum hæmorrhage.

The clinical association of chorionepithelioma with the puerperium is of considerable importance, and a short description of this disease is accordingly necessary.

Chorionepithelioma

(Synonyms : Deciduoma malignum ; syncytioma malignum ; carcinoma syncytiale.)

Chorionepithelioma is a malignant tumour arising either in immediate, or more or less remote, connection with pregnancy, and situated most commonly, but not invariably, in the uterus ; in this organ it forms a soft hæmorrhagic growth occupying the usual site of the placenta—*i.e.* the fundus and adjacent portions of the anterior and posterior uterine walls (Fig. 276). The primary growth may, however, be situated in the vaginal walls, the labium majus, the Fallopian tube, or the ovary. The disease is characterised clinically by the occurrence of irregularly recurrent and often violent hæmorrhages in the puerperium, following an abortion or, more rarely, a full-time labour ; the interval between the end of pregnancy and the onset of these symptoms is, however, very variable. Other symptoms quickly appear—viz. a foul discharge, progressive anæmia, cachexia, fever, and sometimes rigors. Metastatic growths are quickly formed, and in many cases this tumour destroys life with almost unexampled rapidity. After much discussion, and many contradictory observations, it has now been definitely proved that it arises from the chorionic epithelium, both layers of which are represented in the specific cellular elements of the tumour. It therefore is clearly of embryonic, not maternal, origin.

Microscopical Characters.—The cell elements which are typical of this tumour are the following (Fig. 277) : (1) large irregular multinucleated masses of protoplasm (plasmodia), in which cell boundaries cannot be recognised ; these are derived from the syncytium ; (2) small polyhedral cells with large nuclei lying in closely packed masses ; these are derived

from Langhans' layer; (3) large mononucleated cells, and multinucleated giant cells, collected in masses, or invading the stroma of the uterine tissues; these are probably derived

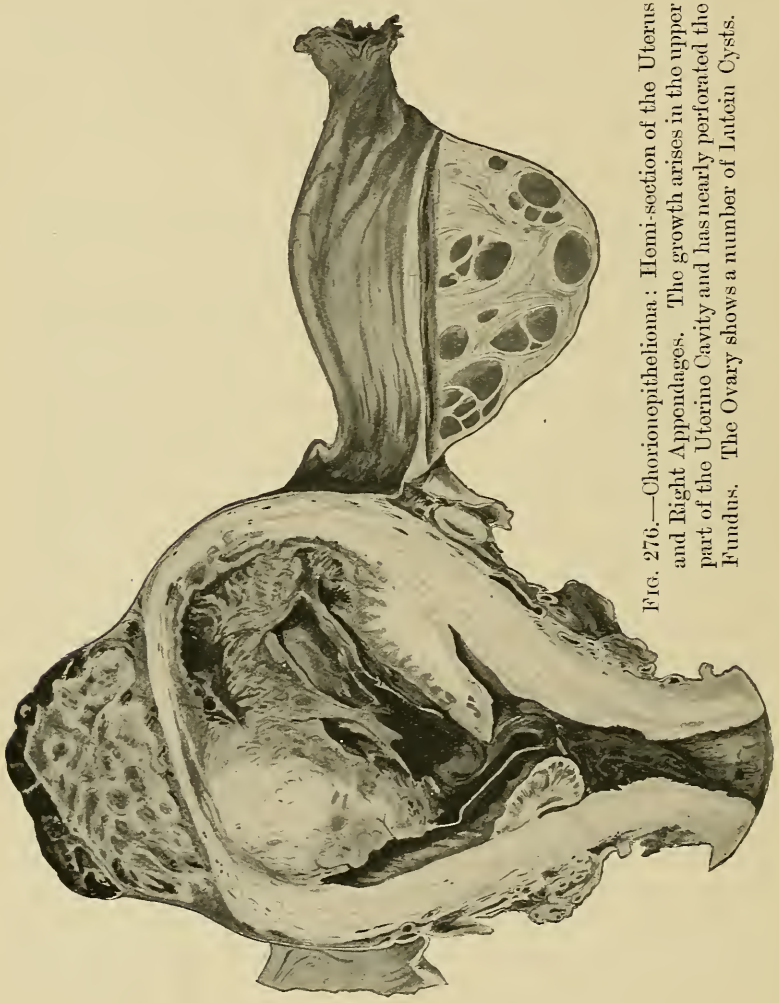


Fig. 276.—Chorionepithelioma: Hemi-section of the Uterus and Right Appendages. The growth arises in the upper part of the Uterine Cavity and has nearly perforated the Fundus. The Ovary shows a number of Lutein Cysts.

from both (1) and (2). In addition to these elements, definitely recognisable chorionic villi are sometimes present, either of normal appearance or in a condition of hydatidiform degeneration; from these villi the origin of the three varieties of cells just described has been traced by a number of

different observers (Fig. 277). The tumour elements show remarkable powers of invasion; they attack the uterine tissues, and perforate the walls of the blood-vessels (usually veins), and thus become disseminated by the blood-stream. This accounts for the unusually rapid formation of metastases. The tumour tissues themselves contain much effused

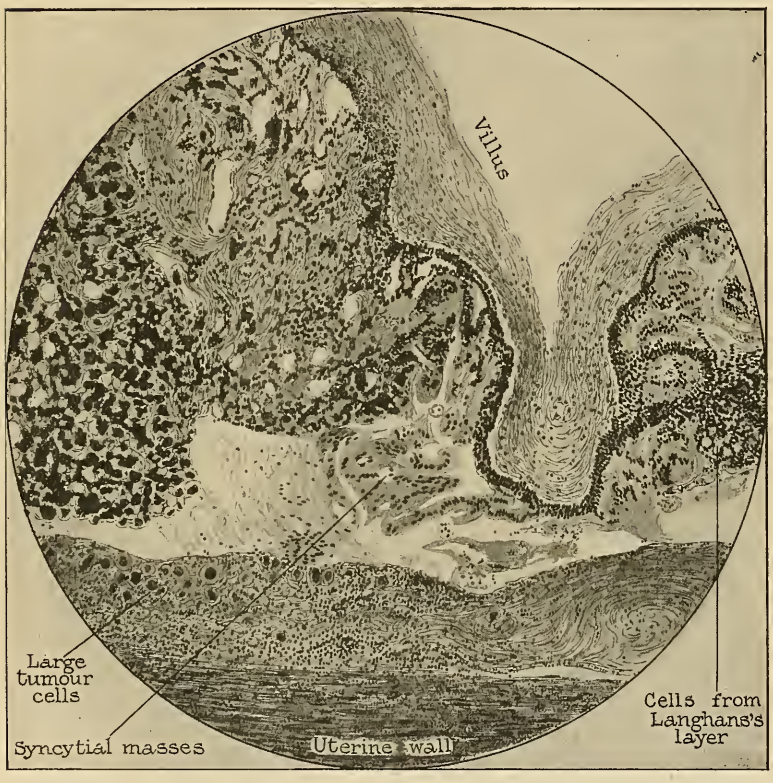


FIG. 277.—Chorionepithelioma: Low Power; showing the origin of the Plasmodia and Cellular Elements from a Villus. (Teacher.)

blood and tend to undergo rapid necrosis; the greater part of the growth is usually found to consist of *débris* of broken-down tissue and clot; only at the growing edge can the characteristic elements be found.

The striking resemblance of the cell elements of this tumour to the malignant or perforating variety of hydatidiform mole has been referred to on a previous page; this

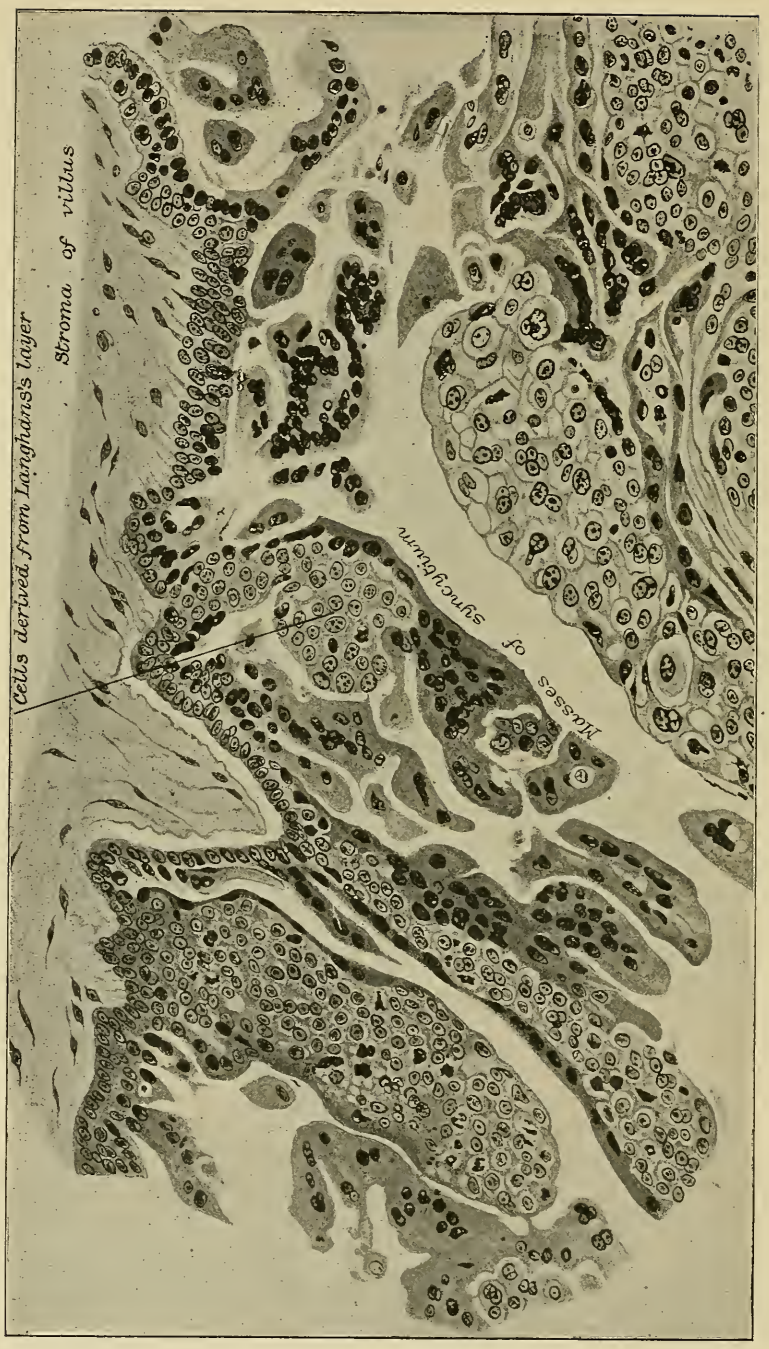


Fig. 278.—Chorionepithelioma; showing the Character of the Plasmodia and Cellular Elements. A portion of Fig. 277 more highly magnified. (Teacher.)

constitutes one of the chief difficulties in the microscopic diagnosis of chorionepithelioma.

Clinical Diagnosis —Cases of chorionepithelioma following quickly upon an abortion have been frequently mistaken for sapræmia with retention of placental tissue, and treated as such. Both conditions are attended with hæmorrhage, a foul uterine discharge, fever, enlargement of the uterus, and the presence within it of decomposing *débris* of tissue or blood-clot. Clearing out the uterus brings a temporary improvement in cases of chorionepithelioma, but sooner or later the symptoms all recur with severity, and the uterus is again found to contain considerable masses of *débris*, although completely evacuated at the first operation. The rapid reproduction of decomposing tissue in the uterus under such circumstances is strongly suggestive of chorionepithelioma. The ultimate diagnosis can only be made by a skilled microscopist, and in cases of doubt the whole of the tissue removed from the uterus should immediately be placed in normal saline solution and sent to the pathologist with as little delay as possible.

Treatment.—Hysterectomy is the only treatment which offers any chance of success. Cases have been recorded in which this operation has been successful even after the formation of definite mestastases in distant parts. It should, therefore, be advised in all cases however advanced, if there is a reasonable chance of the patient surviving the operative procedure.

Reproductive Insanity

Insanity may occur in association with all stages of the reproductive process ; it is usual to describe as separate conditions the insanity of *pregnancy*, the insanity of the *puerperium*, and the insanity of *lactation*. Cases occurring within six weeks of labour are classed as *puerperal*, those occurring later as cases of insanity of *lactation ;* this distinction is artificial, for puerperal involution is not completed at the sixth week, and lactation commences on the third day. The term ' reproductive insanity ' may conveniently be used to include all three of these varieties.

From the statistics of the Lunacy Commissioners it

appears that, among female patients in this country, cases of reproductive insanity form about 7 to 8 per cent. of the whole, the incidence being rather greater in public than in private institutions. From the records of 259 cases of reproductive insanity from the Claybury Asylum recorded by Jones, it appears that 21·6 per cent. occurred during pregnancy, 40·6 per cent. during the early puerperium, and 32·4 per cent. later than the sixth puerperal week. With regard to the causes of reproductive insanity, three points of special interest may be noted : (1) about 25 per cent. of all cases are said to occur in single women, and in cases of insanity during pregnancy this preponderance is even greater ; (2) in a considerable proportion of cases occurring during the puerperium signs of septic infection are present, and it is possible that the toxic condition of the blood thus induced may determine the outbreak in patients subject to hereditary or other predispositions to mental instability ; (3) the subjects of insanity occurring in connection with lactation are usually debilitated in health by previous child-bearing or by general causes. To these causes must be added in all cases the general personal and hereditary conditions which favour the occurrence of insanity. According to Clouston, the frequency of puerperal and lactational insanity is about 1 to every 400 confinements.

Insanity in pregnancy and in connection with lactation is usually of the depressed melancholic type, and is associated with tendencies to suicide or infanticide ; that occurring in the puerperium is more often of the exalted, maniacal, type. In pregnancy, 80 per cent. of the cases occur after the fifth month ; in the puerperium, according to Rigden, over 90 per cent. occur during the first fourteen days ; in lactation, cases occur with almost equal frequency from the second month to the end of the second year. In puerperal cases the most important premonitory symptom is sleeplessness, which is almost invariably met with ; when associated with headache and slight fever it is of still greater significance. The onset of the disease is often an acute outbreak of mania, associated with great violence and restlessness. Depressed types of insanity, however, may also occur in the puerperium.

The prognosis of reproductive insanity is better than that of any other variety of insanity ; from 70 to 80 per cent. of

all cases are said to recover. The premonitory sleeplessness and headache are best treated by large doses of alcohol and by hypnotic drugs. When the disease fully manifests itself, the patient should be immediately removed to an institution for treatment.

Sudden Death in the Puerperium

Causes of sudden death in the puerperium may be due to *syncope*, *coma*, or *pulmonary embolism*.

Syncope is, of course, most likely to occur in subjects of chronic cardiac disease (either valvular or myocardiac), in cases of profound chronic anæmia, and in cases where profuse hæmorrhage has accompanied labour or followed delivery. It is well recognised that in cases of mitral stenosis or incompetence the danger is by no means over when the child is born ; in a considerable proportion of cases which terminate fatally, cardiac failure occurs in the first week of the puerperium. In some rare instances shock appears to be the cause of the syncope, and sudden death has been known to follow rapid emptying of the uterus, as in precipitate labour, in apparently healthy persons.

Syncope from cardiac disease can only be treated by cardiac stimulation and the administration of oxygen. When following profuse hæmorrhage or such grave accidents as rupture of the uterus intravenous saline transfusion should be performed.

Pulmonary embolism may occur during pregnancy, labour, or the puerperium. It may be caused by detachment of a portion of clot from a healthy thrombosed uterine sinus by violent coughing, by muscular exertion, or during a convulsion ; sometimes it appears to be spontaneous. Pulmonary emboli of this kind may contain a portion of a chorionic villus which has entered a uterine sinus and been carried thence to the lungs. Occasionally air embolism is caused by the injection of air into the uterus ; this has followed puerperal intra-uterine douching, or intra-uterine injections of glycerine for induction of premature labour, when these procedures have been clumsily carried out and air pumped into the uterus. Lastly, pulmonary embolism

may occur in cases of phlegmasia dolens by detachment of a portion of the femoral thrombus.

Pulmonary embolism may cause instant death, but this is rare. Usually some hours elapse during which certain symptoms develop which vary according to the size of the obstructed vessel. If this is large, extreme air-hunger (dyspnœa), with cyanosis, and a rapid feeble pulse are the chief symptoms; if the vessel is small, the symptoms resemble those of shock—pallor, cold surface, and small feeble pulse. Recovery is not impossible in the latter case, although naturally the prognosis is very grave.

The only treatment possible is cardiac stimulation and administration of oxygen.

Coma may occur in the puerperium in the subjects of diabetes, in connection with eclampsia, or from cerebral hæmorrhage.

Part VI

THE NEW-BORN CHILD

General Management

When the child has been delivered in a healthy condition the respiratory process is commenced almost instantly, and after a few ineffectual gasps it cries lustily. The mouth and throat should be immediately cleared out by laying the child on its side and wiping out the buccal cavity and pharynx with a piece of wet cotton-wool twisted round the little finger. Delay in breathing on the child's part may be overcome by lightly flicking or by slapping its body, or by sprinkling tepid water on its face and chest. When breathing has been started the eyes should be wiped with boric acid lotion (1 in 40) to free the lids from vernix caseosa, etc. ; if a purulent vaginal discharge has been present during pregnancy, a solution of 1 in 4,000 perchloride of mercury should be used for this purpose, and afterwards 1 or 2 minims of a 1 per cent. solution of nitrate of silver introduced into the lower eyelid with a dropper ; this procedure, introduced by Crédé, is a reliable prophylactic against ophthalmia neonatorum (see p. 646). The cord may be divided as soon as it has ceased pulsating, or earlier when respiration has been satisfactorily established. Two ligatures of twisted thread, previously boiled, should be applied, one about an inch and a half from the navel, the other an inch further away ; that on the fœtal side must be tightly tied with care, and the cord then divided with a pair of sterilised (boiled) scissors. Careful antiseptic precautions are required in ligaturing and dividing the cord on account of the danger of umbilical sepsis.

The infant's bath is usually undertaken by the nurse, but the medical man must see that the work is properly done. The amount of vernix caseosa varies greatly ; when there is a good deal it can best be removed by the use of warm olive

oil and swabs of cotton-wool. Unless all vernix is removed from the folds of the skin at the groins and axillæ, cutaneous irritation will afterwards be caused. The infant may then be placed in a bath of soap and water at a temperature of 100° F. The medical man must afterwards examine the child's body and make sure that no congenital defect is present, such as cleft palate (which would hinder suckling), hernia, undescended testicle, or imperforate anus; the immediate recognition of the latter defect is a very important matter, both for the credit of the doctor and the chances of survival of the child. In the case of a difficult labour, the possibility of obstetric injuries to the head or limbs must be borne in mind. Occasionally an infant is born with one or two teeth already erupted: they are usually central lower incisors. The position of the *caput* in head presentations may be noted for confirmation of the clinical diagnosis of position. It must, however, be borne in mind that the position of the *caput* tends to change after birth by gravity: thus if the child is laid upon its side the fluid in the *caput* tends to gravitate to the dependent part of the scalp. The stump of the cord should be examined to make sure that the ligature is secure, the cut surface painted with tincture of iodine, and a sterilised dressing applied so as to envelop it; or the cord may first be dusted over with powdered boric acid, and then enclosed in boric lint. The scorched linen rag which is popularly employed in many parts of the country for this purpose is a very fair approach to a sterilised dressing. The nurse must take the greatest care to keep the cord surgically clean during the process of shedding. The child should, if possible, be weighed before being dressed, and it is well to keep a regular record of its temperature, taken in the fold of the groin.

It is of great importance that the new-born infant should be carefully protected from cold; weakly infants are especially susceptible to chill, the results of which are often serious. It should therefore be kept well wrapped up in a cot warmed with hot-water bottles; the water used to fill the bottles must not be more than warm, and they must be placed *underneath* the blankets on which it lies, as burning is very readily caused by comparatively low degrees of heat in young infants. During the first twenty-four hours the child

sleeps almost continuously, and should be allowed to lie quietly in its cot. It may be put to the breast twice on the first day, and three or four times on the second, for not longer than ten minutes; a little secretion is in this way obtained. In addition, it may be given a teaspoonful of boiled water every three or four hours; this will usually be readily taken, and serves to promote the establishment of the renal secretion. If the child is to be nursed, no other food should be given besides what is obtained from the breasts except in the case of premature infants (see p. 628). Meconium is usually passed freely during the first two days; this consists of a viscid, dark greenish-black odourless material. The amount voided is considerable, and for the first two days the stools consist of this material alone. The urine passed during the first few days is usually scanty, distinctly yellowish in colour, and not infrequently it leaves a deposit of pink urates on the diaper. It nearly always contains a trace of albumen.

Breast Feeding.—The proper food for the new-born child is its mother's milk; unless definite and valid reasons exist for feeding it in some other manner, every child should be suckled by its mother for the first three to six months of its life. This is best for the infant because it is receiving a natural food suited to its special requirements, and best for the mother because a period of mammary activity is a valuable aid to the processes of involution in the genital tract. It must, however, be recollected that cases occur occasionally in which breast milk is abnormal in composition, the element most often deficient being sugar. In such cases the infant will not thrive on the breast. Other instances sometimes occur in which apparently normal breast milk disagrees, and leads to severe digestive disturbances, which at once yield when an artificial food is substituted for it.

Contra-indications for Suckling.—These may be briefly stated, and require little or no comment:

General.
(1) Pulmonary tuberculosis in all stages.
(2) Valvular lesions of the heart with incomplete compensation.
(3) Syphilis.
(4) Acute illness of any kind.

Local. (1) Severe fissures of the nipple.
(2) Acute mastitis, with or without suppuration.
(3) Absence or marked deficiency of secretion.
(4) Incurable retraction of the nipples.

Infantile. (1) Inability to suck from feebleness or from cleft palate.

Composition and Characters of Human Milk.—The reaction of human milk is alkaline, but on exposure to the air it rapidly changes by lactic-acid fermentation, becoming first neutral and finally acid. Its specific gravity varies between 1030 and 1034, and it contains about 88 per cent. of water. In solution are found sugar (lactose), certain nitrogenous substances (casein and a small proportion of lactalbumen, or whey proteid), inorganic salts (chloride of sodium, phosphates of lime, sodium, potassium, and magnesium), and traces of free gases (carbonic acid, oxygen, nitrogen). These various constituents are constantly present, but their proportions vary at different periods of the puerperium. The following table has been compiled by Cameron and Söldner from a recent series of observations, and their results have been generally confirmed by others :

Period.	Proteids.	Fat.	Sugar.	Mineral Salts.
1st week	2·0%	2·8%	5·4%	0·34%
2nd ,,	1·6%	3·1%	6·2%	0·27%
4th ,,	1·1%	3·8%	6·4%	0·22%
3rd month	1·0%	2·9%	6·7%	0·20%

An analysis of 94 samples of human milk by Carter and Richmond, taken at varying periods of the first month of the puerperium, gives the following arithmetical mean :

Specific gravity	1030 to 1031
Water	88·04
Proteid	1·97
Fat	3·07
Sugar	6·59
Ash (salts)	0·26

It will thus be seen that the secretion of the first week contains the largest proportion of proteids and salts ; after

this period the proportions of these constituents steadily diminish. Fat is found to increase up to the end of the first month, and then to fall considerably; sugar steadily increases in proportion to the end of the third month. The average ratio of proteids to carbohydrates (sugar and fat combined) is 1 to $3\frac{1}{2}$. Human milk is to be regarded as a food of somewhat variable composition, and it is probable that a corresponding variation exists in the nutritional requirements or the digestive capacities of infants. The mammary secretion of a multipara is believed to be less variable in amount and constitution than that of a primipara. Slight variation in the proportion of proteid, fat, and sugar in human milk appears to exert little influence upon the progress of the child.

The daily amount secreted by the mammary glands is estimated at from 1,000 to 1,200 grammes. This figure has been arrived at from estimating the amounts withdrawn from the breasts by the infant at its feeds (*vide infra*, Test-Feeds). The presence of micro-organisms in the milk of healthy women has been already mentioned.

Diet is an important factor in maintaining the process of lactation; food rich in proteids and carbohydrates, but simple in form, and accompanied by a liberal allowance of fluid, is best for a nursing woman. In such a diet milk will obviously form an important item. Alcohol is not necessary. Fruit and green vegetables must be taken with caution, as they frequently affect the milk and cause digestive disturbances in the child. The greater number of purgative drugs also find their way into the lacteal secretion and act upon the child, castor oil being the chief exception. The quality of the lacteal secretion may be injuriously affected by nervous shock, emotion, fits of anger, hysteria, and other nervous disturbances, but we have no precise knowledge of the nature of the changes which occur in it. From this it follows that women of a pronounced emotional temperament do not make good nurses. When menstruation occurs in nursing women, the monthly period is accompanied by a diminution in the total amount of the mammary secretion and an increase in the proportion of solids. The effect of the occurrence of pregnancy is variable, and often no influence at all appears to be exerted by it on the mammary function.

When suckling by the mother is impracticable from the first, or has to be prematurely abandoned, the infant may be brought up by *artificial feeding* or by a *wet-nurse*.

Growth and Progress of the Child.—The only true test of successful feeding is the condition of the child. During the first three days it loses weight owing to the evacuation of the meconium and to loss of fluid through the kidneys and the lungs ; this loss seldom exceeds 5 or 6 ounces, but in the child of a primipara loss of weight may continue up to the fifth or sixth day owing to tardy establishment of full mammary activity. The larger the infant the greater is the absolute loss of weight which occurs. At the end of the first week the loss ought to have been made up and the weight at birth regained, but it is not uncommon for progress to be slower than this. During the remainder of the first month a gain of 4 to 7 ounces a week is satisfactory.

Attempts have been made to check the progress of the child by means of *test-feeds*, *i.e.*, the infant is carefully weighed upon delicate scales immediately before and immediately after suckling. Observations upon series of cases have shown that the amount of milk taken from the breast by the same infant at different meals varies to a remarkable extent, the difference being as great as 1 to 7 or 1 to 8. And, further, infants of approximately the same age and weight do not consume the same quantity of milk in twenty-four hours. The large amounts occasionally taken from the breast by young infants without injury tend to show that the capacity of the stomach increases more rapidly than was supposed. Calculations of the daily total made from a single test-feed are quite unreliable (Forsyth).

About the third or fourth day the character of the infant's motions begins to alter ; the meconium disappears, and fæcal matter, yellow in colour, alkaline in reaction, and of the consistence of custard, takes its place. Three or four motions are usually passed daily. Digestive disturbances immediately affect their character (see p. 631). The umbilical cord should undergo dry aseptic necrosis ; a line of demarcation forms at its junction with the abdominal wall, and about the fifth or sixth day, under normal conditions, it separates spontaneously, leaving a small clean ulcer, which cicatrises rapidly. It is, however, not very uncommon for the root of the cord

to undergo a moist form of necrosis without offensive odour, and under these circumstances separation may be delayed until the second or even the third week. A cord in this condition must be treated with the most scrupulous care, and kept covered with boric acid or some other non-irritating antiseptic such as aristol. The skin of a healthy infant often desquamates during the first week. Towards the third or fourth day the skin becomes of a yellowish tinge, and in some cases the conjunctiva becomes similarly coloured. This is the result of a physiological process of hæmolysis occurring in the liver, and is not a true jaundice, the pigment being derived from the blood, not from the biliary secretion. It passes off in a few days, and is not associated with any unfavourable symptoms.

Artificial Feeding.—Two substitutes for human milk may be employed—viz., the milk of the cow and the ass; the comparative composition of these three is shown in the following table (Rotch):

—	Human Milk.	Cow's Milk.	Ass's Milk.
Sp. G. . . .	1028 to 34	1032	1030
Proteid . . .	1 to 2 %	3·5%	2·2%
Fat	3 ,, 4 %	4·0%	1·6%
Sugar . . .	6 ,, 7 %	4·5%	6·1%
Salts . . .	0·1 ,, 0·2%	0·7%	0·5%

During recent years an elaborate study has been made of the composition of cow's milk and the variations which it undergoes. It has been found that, while the average composition is as stated in the table, wide variations occur in the milk of different kinds of cows, and also in the milk of any single animal from day to day. By using the mixed milk of a herd, greater uniformity of composition can be obtained than with the milk of a single animal. This is directly the contrary of what was formerly believed to be the case. We have seen that human milk is also subject to considerable variations in composition; according to Rotch, this is especially the case with the proteids, which may vary from 1·08 per cent. to 4·14 per cent. without producing any ill effect upon the child. It will accordingly be understood that the above table sets forth the average proportions only.

It may be said generally that cow's milk differs from human milk in being acid in reaction, in containing considerably less sugar and considerably more proteid, while the percentage of fat is about the same ; further, the proteids of cow's milk differ in being less easily digestible than those of human milk. Milk proteids are of two kinds : *caseinogen* or coagulable proteid—*i.e.*, coagulable by the enzyme of rennet, and *whey proteids* or non-coagulable proteids—*i.e.*, those which remain in solution after treatment with rennet. The percentage amounts, according to Koenig, are :

	Human.	Cow.
Caseinogen	0·59%	2·88%
Whey proteid	1·23%	0·53%

The practical result of this difference is that the curd of cow's milk is coarser and more difficult to digest than that of human milk.

It must also be borne in mind that cow's milk is liable to contamination with pathogenic organisms, and certain epidemic diseases, such as scarlet fever and diphtheria, may be propagated by it. From the use of such preservatives as boric acid, which are often added to milk in hot weather in order to prevent the occurrence of fermentation, acute gastro-intestinal irritation may be set up. And, further, tuberculous disease is not uncommon in cows, sometimes affecting the udders, but more often the respiratory system. The milk of animals thus affected contains active tubercle bacilli, by which the disease may be set up in the infants to whom it is given. Fermentation may occur in cow's milk, rendering it extremely irritating to the gastro-intestinal mucous membranes.

Ass's milk more closely resembles human milk in composition, not only as regards the proportions of its elements, but also, it is believed, in the digestibility of its proteids. The amount of fat is, however, much less than in human milk. The remarks made as to the contamination of cow's milk apply equally to ass's milk. The practical objection to the use of ass's milk is that it cannot be obtained except in large towns, and its cost is prohibitive to all but the rich. Accordingly the staple substitute for human milk is cow's milk.

The preparation of cow's milk for infant feeding is a matter of the highest practical importance ; the two

important steps are sterilisation, and modification in composition.

Sterilisation.—The simplest way to sterilise milk is to boil it for ten minutes ; the boiling-point of milk is 220° F. This destroys all bacteria, including their spores. The objections to boiling are (1) that it impairs the flavour of the milk ; (2) that it destroys certain elements, of unknown composition, upon which its antiscorbutic properties depend. Constipation, scurvy, and rickets are believed to be produced by its prolonged use. Boiling is therefore not to be advised. The second method is to place the milk to be sterilised in a water-bath, raise the water to the boiling-point, maintain it at this temperature for twenty minutes, and then remove the vessel containing the milk and allow it to cool. If the milk-containing vessel is only three-fourths immersed in the boiling water the temperature of the milk does not rise much above 180° F. This method is often spoken of as ' sterilisation.' A third method is to employ a water-bath in the same manner, but to raise the temperature of the water only to 170°—175° F., and maintain it at that temperature for thirty to forty minutes. The temperature of the milk will be about 160° F. This is often called ' Pasteurisation.' ' Sterilisation,' so-called, destroys practically all germs except the anthrax bacillus, but does not destroy their spores. ' Pasteurisation ' produces much the same result, and if repeated two or three times, milk may be rendered absolutely sterile in this manner. Unknown chemical changes are induced in milk by heat, and it is therefore desirable to employ the method in which the temperature used is the lowest.

Experience of the use of sterilised milk has shown that it loses some of its nutritive value in the process.

If a fresh and uncontaminated supply of milk can be obtained, this is preferable to any method of sterilisation, but it is agreed that the ordinary milk supply of most towns absolutely requires to be sterilised.

Modification.—The composition of cow's milk can be approximated to that of human milk in respect of the proportions of the principal ingredients. First the milk is diluted to reduce the percentage of proteids to about one-third ; this will be done by adding two parts of diluent to one of milk. But this procedure will reduce the proportions

of fat and sugar to a point much below their level in human milk ; therefore fat in the form of cream, and sugar in the form of lactose, are added to the diluted milk in order to bring up their proportions to the proper level. Thus, if one part of milk is diluted with two parts of water, the proteid in the mixture will be about $1\frac{1}{3}$ per cent. ; this is a little too low, but it must be recollected that the proteids of cow's milk are less easily digested than those of human milk. Cream as sold at dairies varies in the percentage of fat which it contains from 10 per cent. to 20 per cent. ; when in the case of delicate children accuracy is desirable, the fat may be estimated at a laboratory. A sufficiently exact 10 per cent. cream can be prepared domestically by allowing a quart of fresh whole milk to stand in a quart measure for six hours : the upper eight ounces will consist of 10 per cent. cream ; or, if more exact proportions are desirable, a separated (centrifugalised) standardised cream of 16 per cent. can be obtained from most of the large dairies. By dilution of one to two, the proportion of sugar in milk is reduced to about one-fourth of the required amount. A little is replaced by the added cream ; the remainder can be made up with lactose.

Although the proportions of the chief ingredients can be thus adjusted, certain differences will remain—viz., the acid reaction, and the comparatively high percentage of caseinogen (coagulable proteid). The reaction can be adjusted by using lime-water as a portion of the diluent ; the digestibility of the proteids can be increased by the use of citrate of sodium in doses of one grain to each ounce of the prepared food. This salt possesses the useful property of retarding the coagulation of all forms of albumen.

A modified milk suitable for the first week of infant life may therefore be made up as follows :

Whole milk	5 oz.
Water	13 oz.
Lime-water	$1\frac{1}{2}$ oz.
Cream (10%)	$2\frac{1}{2}$ drs.
Lactose	2 tablespoonfuls
Citrate of soda	20 grs.

The pint of food thus prepared is sterilised before use by one or other of the methods just described. The most con-

venient apparatus is that of Soxhlet (Fig. 279). During its first week of life the infant requires about ten feeds in twenty-four hours. Into each of the ten bottles provided sufficient of the feeding mixture is poured to make one feed. All the bottles are simultaneously heated in the water-bath to the temperature desired and their mouths closed with the special rubber cap supplied. They are then removed, and as the contents of the bottles cool the rubber caps become drawn in by atmospheric pressure, rendering them practically air-tight. Thus the day's supply is prepared without undue trouble.

The amount for each feed during the first week is $1\frac{1}{2}$ ounce. At the beginning of the second week the amount is increased

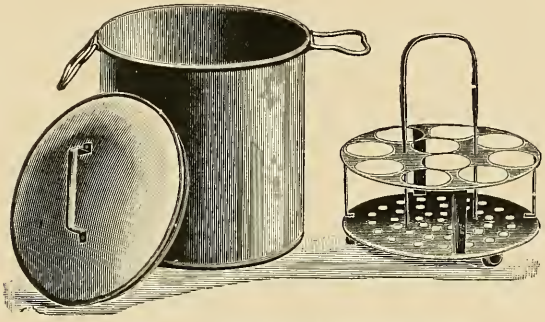


Fig. 279.—Soxhlet's Milk Steriliser.

to 2 ounces. The feeds should be given every two hours in the day, and every three to four hours at night; after the fourth week $2\frac{1}{2}$ ounces can be given at each feed. The degree of concentration should be gradually raised thus: third week, milk $6\frac{1}{2}$, diluent $13\frac{1}{2}$; fourth week, milk 8, diluent 12; sixth week, milk 9, diluent 11; eighth week, milk 10, diluent 10 (in 20 ounces). Whole milk can generally be given to an infant three months old.

A bottle, with a large rubber teat and without tubing, should be employed; after use, the bottle and the rubber teat should both be boiled for ten minutes, and kept immersed in boric acid lotion until again required. The infant's mouth should receive the same attention as in breast feeding.

Healthy infants with normal digestive capacity almost invariably thrive upon this method of feeding. Sometimes

infants are unable properly to digest cow's milk, and some further modification is then required. When the infant is not properly digesting its food the stools, instead of being of the smooth, uniform consistence of custard, become more or less granular or even lumpy, and frequently, from fermentation, they become green in colour and acid in reaction. Looseness or diarrhœa usually accompanies these changes, but sometimes there is constipation. The infant is restless, or sometimes cries after feeding, instead of falling asleep as is the case in health. Colicky abdominal pains often occur, indicated by loud crying or screaming, in which the legs are firmly flexed on the abdomen ; often the spasm of pain is relieved by the escape of a little flatus. At the same time the infant gains little weight, or may actually lose weight. Under such circumstances cow's milk diluted and modified in the manner above described, and then peptonised for periods varying from ten to thirty minutes, may be used ; or the preparation sold as ' humanised ' milk may be substituted for it. This preparation is easily digested ; however, infants gain in weight but slowly upon it, and its use for prolonged periods is undesirable. In severe cases a very useful substitute for milk may be found in a mixture of whey and cream, usually called the ' whey-cream mixture.' Whey differs from whole milk in being almost entirely free from the coagulable proteids, and in containing but a small percentage of fat. The composition of whey, according to Koenig, is as follows :

Proteid . . .	0·86%	Salts . . .	0·63%
Fat . . .	0·32%	Water . .	93·38%
Sugar . . .	4·90%		

The proteid elements which are most difficult to digest having been eliminated, this food is very suitable for premature or delicate infants, and may be given in the proportions of whey ʒiss., cream ʒj. for each feed. The mixture must of course be sterilised.

In America a system of modifying cow's milk by laboratory processes, so that the various ingredients may be combined in any required proportions (*humanised milk*), has been widely adopted, and it is customary for the physician to prescribe the exact composition of the milk he orders, and

vary it from week to week as he may think desirable. Such methods can only be employed by specialists, but a preparation known as ' humanised milk ' can be obtained from the principal dairies, which will be found more readily digestible than ordinary cow's milk, although its exact composition and mode of preparation are not known. Swiss condensed milk may be used as an alternative to sterilised cow's milk ; in the first week the dilution should be 1 to 16, rising to 1 to 12 for the remainder of the first month. The addition of sugar is unnecessary. Dried milk prepared by rapid evaporation, such as ' Glaxo,' forms a very useful substitute for fresh milk : the food is prepared from it with boiled water, and is free from bacterial contamination.

Mixed Feeding.—When the mammary secretion is insufficient in quantity for the child's needs, but otherwise suitable, artificial feeding should be used in addition, breast and bottle being given alternately, or the one in the daytime, the other at night. Infants thrive well upon this method.

Wet-nursing.—If serious difficulty is experienced in feeding the infant upon cow's milk, and ass's milk is not available, a wet-nurse is the only remaining alternative, and the value of this method of feeding delicate infants cannot be over-estimated. It would be much more widely employed but for the difficulty, so frequently experienced, of obtaining the services of a suitable nurse.

The selection of a wet-nurse throws a serious responsibility upon the medical man. He must be satisfied that the breasts are secreting freely, the nipples healthy and well-formed, and the genital organs healthy. The nurse and her child must both be free from any taint of constitutional disease, such as syphilis and tubercle. In addition she must be of good physique, with sound teeth, cleanly in habits and of good moral character. It is therefore necessary for the medical man to make a complete physical examination of the mother and her child before selecting a wet-nurse. It is difficult to obtain the services of women of respectable character as wet-nurses, and in any case the greatest care is required to ensure against frauds which a candidate may easily practise, as for instance, the substitution of another child for her own. A syphilitic infant must not be brought up by a wet-nurse.

If there is any doubt as to the nurse's freedom from syphilis, the Wassermann test may be applied.

Management of Premature Infants.—Premature infants are distinguished by being below the average length and weight, by deficiency of subcutaneous fat, by persistence of lanugo hair, and by a low degree of vigour, as compared with the full-time healthy child (Figs. 280 and 281).

Much greater care is required in the management of an infant three or four weeks premature than of one at full term, for prematurity implies a low heat production and indifferent digestive activity. Incubation of premature

Fig. 280.—Premature infant, weight 4 lbs. The skin is much wrinkled, and the child is crying feebly.

infants has been much employed, but it is doubtful whether it is really necessary, except in the case of infants of not more than three pounds' weight. The incubator generally used in this country (Fig. 282) is heated by hot-water bottles, which are placed in a closed chamber under the infant's bed; ventilation is permitted by apertures of entrance which communicate with this chamber, and apertures of exit under the roof; a thermometer fixed to one of the glass walls enables the temperature to be kept under observation. A fairly uniform temperature can be maintained (about 85° to 90° F.), but ventilation is very imperfect, and the infant undoubtedly suffers from want of fresh air. Experience shows that with infants of over three pounds equally good

results may be obtained by keeping the child in a warm, well-ventilated room (about 70° F.); it should be screened from draughts, and the bed in which it lies can be kept at a temperature of about 100° F. by the use of hot-water bottles rolled up in blankets. The child should not be dressed in the ordinary manner, but wrapped up in sheets of cotton-wool or

Fig. 281.—Full-time infant, weight 8 lbs. The outlines of the face are rounded, there are few wrinkles, and the child is crying lustily.

Gamgee tissue. It should be disturbed as little as possible, and, although bathing is not advisable, the skin may be kept clean by the daily use of olive oil, with which the whole body should be freely smeared; this probably has also a certain nutritive value, some of the fat being absorbed by the skin.

Feeding may present some difficulties. Premature infants weighing four to five pounds can usually take the breast

satisfactorily ; if not, the breast milk may during the first few days be withdrawn by a breast-pump, and administered with a spoon ; this, however, cannot be continued for long. It is well to begin the feeding of a premature infant without delay, and the whey-cream mixture (see p. 626) is the best artificial food for the first two or three days ; of this a teaspoonful may be given every hour, until the breast secretion is available. These infants sleep nearly continuously, and must be regularly roused for their feeds. When breast milk cannot be used, the amount of whey and cream should be increased to half an ounce every two hours by the end of the

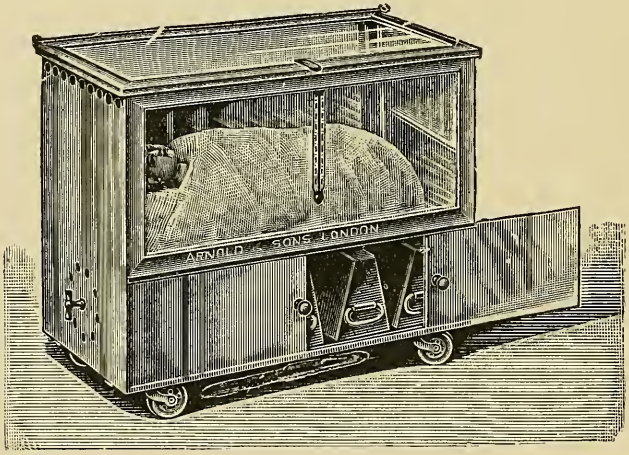


Fig. 282.—Incubator for Premature Infants.

first week, when a modified cow's milk may be substituted for it. Cow's milk when used must be given more dilute—*i.e.*, with a larger proportion of water—than in the case of a full-time child, and the strength must be very cautiously increased. Sodium citrate is particularly useful in assisting the digestion of the caseinogen. The amount and concentration of the food should be very cautiously increased. If the child cannot suck through a teat, the food should be dropped gently and slowly into its mouth through a glass pipette. Sometimes premature infants are at first too feeble to swallow, and they must then be fed through a narrow soft rubber catheter passed into the stomach.

Premature infants lose comparatively little weight during

the first week, as the amount of meconium and urine which they pass is small. Even when no difficulties in feeding are encountered the rate at which they gain weight is very slow for the first three or four weeks.

Digestive Disturbances.—In breast-fed babies digestive disturbances are rare when the mother is healthy, the condition of the mammary glands satisfactory, and the necessary precautions are observed in keeping the nipples and the child's mouth clean. In bottle-fed babies they are much more common, and are due either to the kind of food in use being unsuitable to the child, or from failure to observe the necessary rules of cleanliness already laid down. Digestive disturbances are indicated in infants by abdominal symptoms such as colic, vomiting, constipation, or diarrhœa; by the parasitic eruption known as *thrush*, and by loss of weight or failure to increase in weight. *Colic* is indicated by attacks of violent screaming, in which the legs are drawn up to the abdomen; the attacks are often suddenly relieved by the passage of flatus. *Vomiting* after feeding may be due to the infant having over-filled its stomach or taken its meal too quickly; sometimes it is due to the food containing an excess of fat. In cases of persistent vomiting the possibility of *pyloric stenosis* must not be overlooked. This condition is characterised by frequent attacks of vomiting, in which the ejected food is thrown out with remarkable violence, the so-called *projectile vomiting*. When this sign is not present, physical evidences of dilatation of the stomach may be found, the peristaltic wave crossing the epigastrium from left to right being fairly characteristic. *Diarrhœa* is usually accompanied by a greenish discoloration of the stools, the result of an acid fermentation, and sometimes in bad cases they contain fragments of undigested milk curd. It also usually causes redness and irritation of the skin around the anus, which may spread over the buttocks and inner sides of the thighs. *Thrush* is characterised by the appearance of a crop of slightly elevated, circular, white spots in the mouth and throat, and sometimes within and around the anus. They are due to a fungus—*oïdium albicans*—which can be readily detected by the microscope in the scrapings from these patches. It is always accompanied by some or all of the symptoms of disturbed digestion. On inquiry the condition

can usually be traced to the use of dirty bottles or teats, or to lack of attention to the child's mouth. Wasting from unsuitable feeding must be distinguished from constitutional conditions such as syphilis.

Digestive disturbances are to be treated not so much by drugs as by regulation of the quantity and quality of the food, and by strict attention to cleanliness. A common error in artificial feeding is giving the food in a too concentrated state ; no rule will apply to every case, and increased dilution may often be advisable even when the food is apparently not too concentrated. The poor often administer starchy food to very young infants ; this is quite unsuitable, for the amylolytic digestive ferments are undeveloped in the infant. Another common error is the use of artificially prepared patent foods for infants ; these are all deficient in fat, which is one of the most useful and most easily digested elements of an infant's food, and wasting is accordingly very apt to occur. Barley-water or rice-water may be used instead of plain water for diluting the milk in digestive disturbances. If the child does not thrive on cow's milk prepared in the manner described, a wet-nurse or a supply of ' humanised ' milk or of ass's milk should be obtained instead. Constipation can often be relieved by a slight alteration in the food ; increased dilution or the addition of an excess of cream will often suffice. Drugs should be avoided, but ʒj. of olive oil may be given occasionally when required. Diarrhœa is best treated by a single dose of a mixture of castor oil ʒss., with olive oil ʒiss., followed by a change of feeding. Severe cases of diarrhœa with vomiting may be treated as follows : a teaspoonful or two of boiled water (warm) every hour for twelve hours ; then a teaspoonful of whey every hour for twelve hours ; then two teaspoonfuls of the whey-cream mixture every hour for twelve hours. Thrush needs no special treatment beyond the cleansing of the mouth with boro-glyceride, and attention to the food and to the condition of the bottles and teats.

Acute gastro-enteritis may result from persistence in unsuitable feeding, or from infection of the alimentary canal by contaminated milk. It is almost unknown in breast-fed babies. It is one of the most serious disorders of early infancy, and is attended by a high mortality. The chief

symptoms are persistent vomiting and diarrhœa, with collapse, indicated by coldness and cyanosis of the face and limbs. There is usually great irritation and some excoriation of the skin of the buttocks, and general cutaneous eruptions of varied types and distribution are often present. The treatment is, in the first place, to stop the administration of food entirely for twenty-four to forty-eight hours ; during this period sterile saline solution may be injected under the skin, with strict antiseptic precaution, in small quantities of about 1 ounce every three or four hours. Then boiled water or albumen water in small quantities should be given, and if a wet-nurse cannot be obtained, the whey-cream mixture may be cautiously given or well-diluted peptonised cow's milk. The question of food is all-important, drugs being of little use.

Obstetric Injuries and Diseases of the Fœtus

Asphyxia Neonatorum (Still-birth).—Asphyxia, which literally means *pulselessness*, has come by usage to mean interruption of the respiratory function, and is now used in this sense only. Asphyxia in the new-born child may arise *in utero* from complications of labour, in which case the child is born asphyxiated (intra-uterine suffocation); or it may arise from failure to establish pulmonary respiration when born, in which case the asphyxia comes on after delivery. The latter is very rare, the former is common.

Respiration, as it is found in the fœtus *in utero*, consists in a gaseous exchange between the fœtal blood and the maternal blood effected through the placenta. Therefore anything which causes interruption, partial or complete, of the placental circulation, either fœtal, through the villi, or maternal, through the inter-villous spaces, will tend to induce intra-uterine asphyxia. The following conditions may accordingly cause it : (*a*) *Premature detachment of the placenta* (ante-partum hæmorrhage). (*b*) *Compression of the cord* (cord prolapsed, or tightly coiled round the fœtus, or caught by the after-coming head). (*c*) *Tonic uterine contraction*, causing continuous compression of the placenta. These conditions may all be complicated by *blocking of the fœtal air-passages with fluids from premature respiration in utero*, due either to

cutaneous stimulation (breech cases), or to partial interference with the placental circulation, which, by causing accumulation of carbonic acid in the blood, stimulates the respiratory centre before paralysing it.

Failure to establish the pulmonary respiratory function after birth may be due to (*a*) *head injuries* causing interference with the action of the respiratory or vaso-motor centres in the medulla ; and (*b*) such *congenital defects* as stenosis of the trachea or the pulmonary artery. Obviously cases may be met with in which the causation is complex—*e.g.* blocking of the air-passages with fluids may be associated with injury to the head received in difficult labour.

The asphyxial phenomena in new-born infants will depend in the main upon the extent and duration of the interference with the placental circulation which has preceded delivery. The commencement of the process of asphyxia is characterised by cyanosis and high blood-pressure ; this phase is commonly known as *cyanotic* or *blue asphyxia*. Later on the blood-pressure is reduced, the circulation fails, and the skin becomes pale ; this phase is called *pallid* or *white asphyxia*, and is, of course, more serious than the former.

Cyanotic Form.—This form of asphyxia is characterised by the deep blue or purple tint of the skin, and by other appearances suggestive of suffocation—*e.g.* half-opened eyelids and injected conjunctivæ ; there is also slight muscular rigidity of the limbs, with preservation of the cutaneous reflexes. The heart usually beats vigorously, and its movements can be readily seen and felt through the chest-wall ; sometimes in more severe cases only feeble cardiac movements can be detected.

Pallid Form.—In this form the skin is blanched, the limbs are flaccid from complete loss of muscular tone, the eyes closed, the pupils dilated, the umbilical cord almost pulseless, and the cardiac movements feeble ; they may be unrecognisable except by the stethoscope. All the reflexes, superficial and deep, are lost, the sphincters often being relaxed so that urine and meconium escape.

In both forms the child makes no voluntary movements ; hence the time-honoured name of *still-birth* applied to the condition.

The probability of the child being born in a condition of asphyxia may be sometimes foretold during labour ; thus direct evidence of *fœtal distress* may be afforded by slowing and enfeeblement of the fœtal heart-sounds, or by the passage of meconium in cases other than breech presentations. In breech presentations, difficult forceps cases, and cases of ante-partum hæmorrhage, there is always an increased risk of still-birth. Accordingly, under all such circumstances, preparations for resuscitation should be made before delivery.

Treatment.—The first step is to clear the mouth and throat of fluids ; this may be done by laying the child on its side and wiping out the throat with pledgets of wet cotton-wool ; or by holding it up by the feet for a moment or two so as to allow retained fluid to escape from the throat. In a case of cyanotic asphyxia attention may then be solely directed to exciting the respiratory centre ; in a case of pallid asphyxia, cardiac is quite as important as respiratory stimulation. The treatment of the two conditions is accordingly somewhat different.

In *cyanotic* asphyxia, when the heart beats strongly, vigorous measures may be adopted, such as sprinkling the chest with cold water, flicking the trunk with a towel dipped in cold water, or momentarily immersing the trunk and limbs of the child in tepid and warm baths alternately (temperature about 60° and 105° F.) ; or, while in a warm bath, cold water may be sprinkled over its head. As the cutaneous reflexes are preserved, these measures usually produce a considerable effect upon the respiratory centre. If they fail to excite any response, artificial respiration must be at once employed. When, in this form, the cardiac pulsations are feeble at the outset, artificial respiration should be begun as soon as the throat has been cleared.

In *pallid* asphyxia the greatest care must be taken to preserve the body-heat and to maintain the circulation. A useful method is to immerse the infant's body in a warm bath (105° F.) for several minutes, holding its head clear, gentle friction being used meanwhile to the trunk and limbs ; by gently compressing the base of the chest between the hands, and then allowing the chest-wall to recoil, artificial respiration may be practised at the same time. Or the child may be laid over a hot-water bottle well protected with blankets,

and a rectal injection of ʒj. to ʒij. of warm saline solution may be administered. Cutaneous stimulation of the respiratory centre is impracticable, as the cutaneous reflexes are lost,

Fig. 283.—Schultze's Method of Artificial Respiration. First or Inspiratory Position.

and accordingly artificial respiration should be begun with as little delay as possible.

Methods of Artificial Respiration.—While many may be practised upon the adult, only three are of practical importance in the case of the new-born child.

(1) *Schultze's Method.*—The body of the child is held by the shoulders, the thumbs passing over the clavicles, the fingers supporting the back ; the ulnar margins of the hands are sufficiently separated to allow the head to lie between them in a position midway between flexion and extension, so as to allow free passage of air through the glottis. This is the *first* or *inspiratory position* (Fig. 283) : the lower limbs hang down, so that the trunk is extended ; in this attitude the diaphragm is drawn down to the lowest possible level, and air is thus drawn into the lungs. The body of the child is then swung lightly into the position shown in Fig. 284 ; this is the *second* or *expiratory position*. The trunk is now flexed, and the weight of the lower limbs and the abdominal viscera is thrown upon the diaphragm, causing it to ascend and expel air from the lungs. Next the body of the child is allowed to fall back gently into the first position. The head must be held steady by the wrists during these movements, and not allowed to fall forwards against the chest, or the passage of air through the glottis will be impeded. The movements should be regulated so as to produce about twelve to fourteen respirations a minute. The reversed position of the trunk in the expiratory movement is also

Fig. 284.—Schultze's Method of Artificial Respiration. Second or Expiratory Position.

useful in promoting the escape of fluid from the air-passages. When the body is thickly covered with vernix a handkerchief or towel must be used to hold it securely.

(2) *Sylvester's Method.*—The child's body is laid on its back, a pillow being placed beneath the shoulders, and the head allowed to hang over the end in a position midway between flexion and extension. If necessary the body may be kept warm by placing beneath it a hot-water bottle well protected in a blanket. The tongue should be pulled out with the corner of a handkerchief, and an assistant is required to hold the feet steady (Fig. 285). The arms are then seized

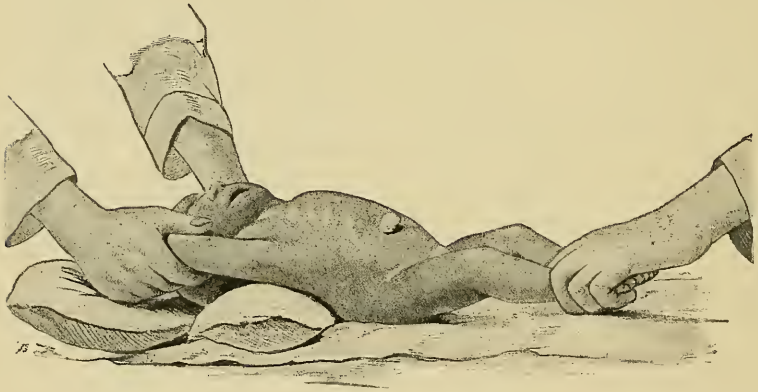


Fig. 285.—Sylvester's Method of Artificial Respiration. First or Inspiratory Position.

by the elbows and gently but firmly carried round by an upward and outward sweep until they lie at the sides of the head (inspiration); next the arms are pressed against the chest-wall (expiration) (Fig. 286). These movements are made at about the same rate as in the former method.

Tongue Traction.—By seizing the tip of the tongue in the corner of a handkerchief, and pulling it firmly forwards, traction is made upon the larynx, and this powerfully excites the respiratory centre; a distinct gasp usually follows immediately. By repeating traction at regular intervals respiration may be maintained in favourable cases. This reflex is often preserved after all the cutaneous reflexes have been lost, but in bad cases of pallid asphyxia it may fail entirely.

This method can conveniently be employed along with Sylvester's method, or while the infant is in the warm bath.

(3) *Insufflation.*—This method is only required when the air-passages have become waterlogged by premature respiration *in utero ;* great difficulty may then be experienced in causing air to enter the lungs by the methods of artificial respiration just described. Insufflation may be practised by the mouth-to-mouth method, or by catheterisation of the trachea. The former is not to be advised, for the greater part of the air blown into the mouth passes down the

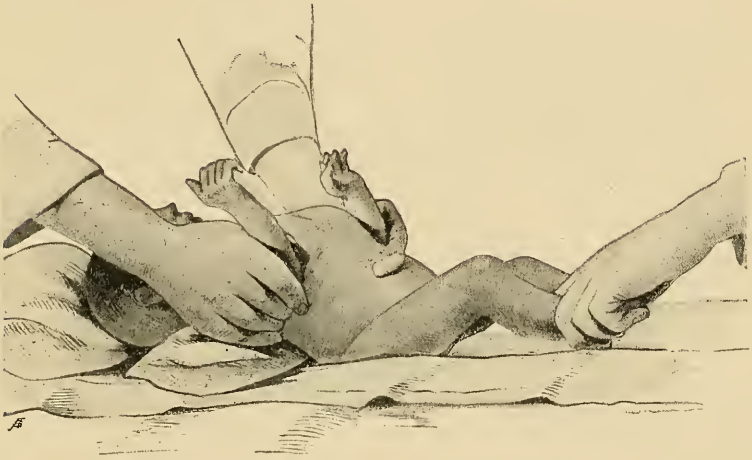


Fig. 286.—Sylvester's Method of Artificial Respiration. Second or Expiratory Position.

œsophagus into the stomach instead of through the glottis. When insufflation is indicated the latter method should be adopted. An ordinary gum-elastic catheter is the only instrument required ; in introducing it the index finger of the right hand should be passed into the throat, over the epiglottis, and the catheter directed along its palmar surface into the larynx. When carefully introduced no injury will be caused to the soft parts by the catheter. Air may be now gently blown into the trachea, and if fluid is present this will bubble up at the sides of the catheter into the mouth, and can be wiped away. When most of the fluid seems to have been expelled, Sylvester's method of artificial respiration should be

resorted to, with the catheter left in position. Used in this manner for merely freeing the air-passages, insufflation is useful. As a method of artificial respiration it is unsatisfactory, first because of the risk of rupturing the pulmonary vesicles and causing emphysema by blowing air too vigorously into them ; and secondly, because the air thus introduced into the child's lungs is exhausted air, loaded with various impurities, and consequently unsuitable for resuscitation. Ribemont-Dessaignes has invented an insufflator, by means of which atmospheric air can be blown directly into the trachea, thus neutralising the latter objection (Fig. 287).

Schultze's method should not be employed in cases of pallid asphyxia on account of the handling and exposure of

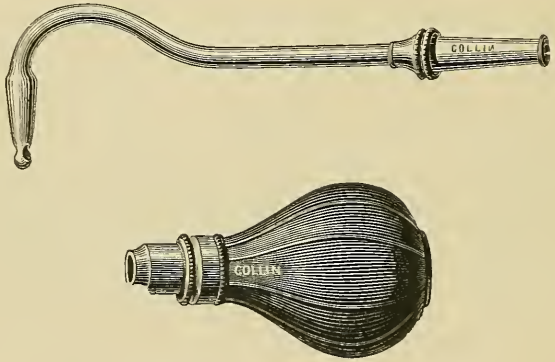


Fig. 287.—Ribemont-Dessaignes's Insufflator.

the child which it entails. Great care and gentleness must be exercised in carrying out the manipulations. Rupture of the liver or the spleen may be caused by too vigorous compression of the trunk in either method. While performing artificial respiration, care should be taken not to interfere with the first irregular spontaneous attempts to breathe which the child may make. At first, long intervals occur between these attempts, during which artificial respiration must be resumed. The condition of the heart must be carefully watched. As long as cardiac pulsations can be made out with the stethoscope there is a chance of success ; when these have definitely ceased the child, of course, is dead. In cases of pallid asphyxia after successful resuscitation the child often remains very feeble, and may die in two or three days from

cerebral injury or from pneumonia—*e.g.* if fluids have been drawn into the air-passages. The prognosis after successful resuscitation is much more favourable with the cyanotic form.

Injuries to the Head.—As a result of injury during labour *hæmorrhage* may occur either outside or within the cranial cavity, or *fracture indentations* of the skull bones may be found.

Hæmorrhage may occur in four different strata : (*a*) into the deep cellular layer of the scalp, *i.e.*, the same position as a caput succedaneum ; (*b*) beneath the pericranium and the aponeurosis of the occipito-frontalis muscle ; (*c*) between the pericranium and the bone (cephalhæmatoma) ; (*d*) between the bone and the dura mater (extra-dural hæmorrhage) ; (*e*) into the pia-arachnoid or the brain substance (cerebral hæmorrhage).

The hæmorrhages which occur in the scalp are not of great clinical importance ; the other varieties deserve some consideration.

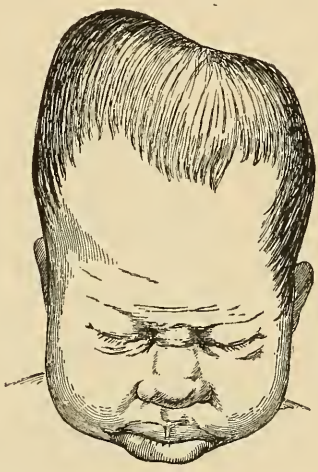


Fig. 288.—Double Cephalhæmatoma. (Ribemont-Dessaignes and Lepage.)

Cephalhæmatoma. — This condition consists in an effusion of blood beneath the pericranium, due to detachment of this membrane during labour. Usually the effusion takes place gradually, and the swelling may not appear for a day or two after birth ; but it may be found on the head at birth. The cause of the separation of the pericranium is unknown ; the bone is very seldom injured, and, though usually occurring after a difficult labour, it is occasionally seen after a normal and easy delivery.

The usual situation is upon one or other parietal bone ; sometimes it is bilateral, affecting both parietal bones ; more rarely multiple cephalhæmatomata are met with. The swelling varies a good deal in size ; it may be no larger than a walnut, when the area of detached periosteum is small ; it may, however, attain the large size shown in Fig. 288.

Though limited by the sutures to the area of the affected bone because at the sutures dura mater and pericranium are united, the effusion seldom spreads over the whole surface of the bone, but is confined to a portion of it. At first it is soft and fluctuating, but soon a dense, hard, rounded edge forms around it, due to osteoplastic changes at the margins of the effusion. The blood remains fluid in the centre and is gradually absorbed, but several months may elapse before it entirely disappears. No treatment is necessary ; incision or puncture is inadvisable.

Intra-cranial Hæmorrhages are by no means uncommonly found in cases of still-birth, and premature infants are specially susceptible of this injury on account of the imperfect ossification of the cranial bones. In 130 autopsies on still-born infants Spencer found that 40 per cent. of them showed intra-cranial hæmorrhages, the greater number being extra-dural in position. All the still-born infants in his series which had been delivered by forceps showed this condition. Very similar results have been obtained by Wallich in a series of 143 still births. Intra-cranial hæmorrhage is, however, not confined to cases of instrumental delivery, as it has been sometimes found when delivery has been natural and apparently easy. Extra-dural hæmorrhages are usually associated with fracture or fracture-indentation of the skull. Extensive intra-cranial hæmorrhage occurring during labour always results in the child being still-born ; occasionally the condition develops after birth and the child may live for a few days. The diagnosis is then a matter of much difficulty ; localising symptoms cannot be expected to develop, but certain general signs indicative of intra-cranial bleeding may be observed. In the early stages the infant is constantly drowsy, the pulse is slow (below 100), and the fontanelles are bulging and tense ; later on trismus, dysphagia and convulsions occur. If a depressed fracture is associated with it, or other signs of injury to the skull, the diagnosis is of course more readily made. In such cases an operation upon the site of the fracture may be undertaken, but naturally the prospect of success is small.

Intra-dural Spinal Hæmorrhages have been found in still-born infants from difficult breech labours.

Depression and Depressed Fractures of the Bones.—This

injury usually results from the pressure of the sacral promontory upon the part of the head with which it is in contact. The indentation or depression is usually oval and spoon-shaped, or shallow and gutter-shaped; in the former the depression is deep at one end of the oval and gradually rises to the level of the general surface of the head at the other. The posterior parietal bone is therefore the one usually

Fig. 289.—Spoon-shaped Indentation of the Right Frontal Bone. The dotted lines show the position of the anterior fontanelle.

affected, and it is much more likely to be caused by a flat than by a normal-shaped pelvis. More rarely it is seen upon the posterior part of the frontal bone, as a result of the lateral gliding movement of the head which occurs in natural delivery through a markedly flat pelvis (Fig. 290). The spoon shape is probably produced by the transverse gliding movement, the posterior end of the depression being deeper than the anterior. It is not always easy to decide whether or not the depressed bone is also fractured. No treatment is

required as a rule, for the bone gradually rises into its proper position ; occasionally signs of cerebral compression occur, and then an operation to elevate it can be practised.

Fissured Fracture of the Skull.—This injury is almost always due to difficulty in delivering the head by forceps or version ; but it may sometimes occur after spontaneous delivery in cases of contracted (flat) pelvis. The posterior parietal bone is the one most commonly injured, and it is compressed by the sacral promontory (Fig. 290). Fracture

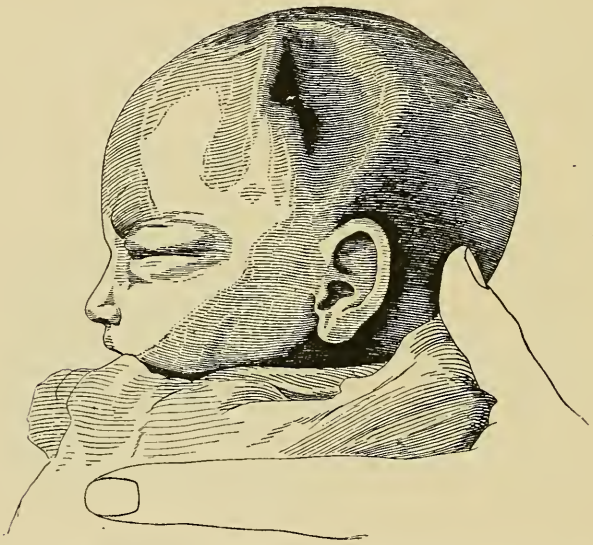


Fig. 290.—Depressed Fracture of the Left Parietal Bone caused by Labour in a Flat Pelvis. (Bumm.)

may be complete or incomplete ; often it is depressed and associated with meningeal hæmorrhage.

Birth Paralyses. — *Facial Paralysis.*—This injury is usually caused by forceps delivery, and is due to compression of the facial nerve in the parotid region by the blade. A few cases have, however, been observed after spontaneous delivery, but their causation is quite obscure. The resulting deformity is characteristic, and consists in an extreme lateral asymmetry of the face. On the paralysed side the eye remains open as the orbicularis is paralysed ; the naso-labial fold is obliterated ; the mouth is open. Owing to the

action of the unaffected muscles being unopposed, the mouth is drawn over to the sound side; the naso-labial fold on the same side is deep. When the child cries extreme asymmetry is produced. Suckling and deglutition are not affected. Often a skin abrasion can be seen below the zygoma on the affected side, indicating where the tip of the forceps blade has caught the nerve. As a rule, the nerve recovers spontaneously in a day or two; but severe cases may be met with in which a certain amount of paralysis persists, and local electrical treatment will then be necessary.

Paralysis of the Arm.—The mechanism of this form of

Fig. 291.— Facial Paralysis in the New-born Child. (Budin.)

paralysis (generally known as Duchenne's palsy) is not well understood, but the immediate cause is injury from overstretching of the brachial plexus or of the nerve roots which supply it. Difficulty in labour is almost invariably associated with it, but some cases have been recorded after spontaneous labour. The muscles most commonly affected are the deltoid, biceps, coraco-brachialis, and supinator longus—*i.e.*, the muscles supplied by branches from the fifth and sixth cervical nerves.

Fractures of Limbs result from unskilful delivery; they may occur in breech presentations, in delivering the legs, or

from difficulty in freeing extended arms ; or in head presentations when there is difficulty in disengaging the shoulders.

Umbilical Sepsis.—Septic infection through the navel may occur when the cord is divided, during the process of separation, or subsequently. Some authorities consider that it is a frequent occurrence, and is responsible in one form or another for about 10 per cent. of the mortality among infants under one month old. This opinion is based mainly upon the results of autopsies, which frequently show internal evidences of sepsis in cases in which its existence was not suspected during life. Local signs of septic infection of the navel may be seen in erysipelatous inflammation of the skin, sloughing or suppuration at the line of demarcation, often accompanied by hæmorrhage, or a sloughing condition of the ulcer left when the cord has come away. In addition to these obvious local appearances, septic arteritis and phlebitis may occur, which spread rapidly up the abdominal portion of the umbilical vessels without giving rise to noticeable external changes. Such cases usually terminate in general dissemination of the septic process by embolism. In tetanus neonatorum, a very rare affection, the organisms probably enter at the navel.

The only effective treatment is prophylactic ; it has been suggested that the cord should in routine practice be amputated close to the abdominal wall, and the skin edges united by stitches at birth. This is unnecessary if the cord is treated systematically with proper surgical cleanliness. The infant should be sponged, not bathed, until the cord has separated and the umbilicus has healed.

Ophthalmia Neonatorum.—This condition begins as an acute purulent conjunctivitis, but may go on to attack the cornea, when it may result in partial or total permanent blindness from opacity ; or complete disorganisation of the eyeball from perforation of the cornea may occur. In a large proportion of cases of persons who have been blind from infancy, gonorrhœal ophthalmia has been the cause of their loss of sight. In 1,100 cases of blindness in children recently investigated by Harman, 24 per cent. were due to ophthalmia neonatorum. Ophthalmia is due to infection ; in very rare instances this may occur *in utero* from infection of the amniotic

fluid, for such cases have been recorded; in the great majority, however, the infection occurs during or immediately after labour; in a smaller but quite definite proportion it occurs in the first few days of extra-uterine life. It is probable that infection occurring immediately after birth is due to particles of vaginal discharge which cling to the eyelids or eyelashes, and gain access to the conjunctival sac when the eyes are first opened. In normal labour the eyelids are tightly closed and probably water-tight during the birth of the head, but in face presentations or in delivering the after-coming head the eyes may be infected by the examining finger. In about 60 per cent. of cases the infection can be proved to be gonorrhœal by the discovery of gonococci in the pus; in the remainder various organisms have been found, including bacterium coli, pneumococcus, Klebs-Löffler's bacillus, and the pyogenic micrococci. Gonorrhœal cases only occur by direct infection from the maternal passages. Other organisms, not derived from pre-existing disease of the maternal passages, may also obtain access in the same manner. A certain proportion of the non-gonorrhœal cases are probably of a simple catarrhal nature. Complications such as keratitis are very much rarer in non-gonorrhœal than in gonorrhœal cases.

The signs of ophthalmia make their appearance during the first four days of life in from 50 to 80 per cent. of all cases; very few cases arise later than the first week. Gonorrhœal cases begin earlier than other kinds, because infection is early, and possibly because the period of incubation of the gonococcus is short. The conjunctivæ become greatly injected and excrete a free purulent discharge; the eyelids become reddened and œdematous, and, from spasm of the orbicularis palpebrarum, distension of the conjunctival sac with pus occurs. On gently separating the eyelids, the discharge will escape in large quantities. Usually both eyes are affected, either simultaneously or consecutively; when one eye at first escapes it is difficult to preserve it from subsequent infection.

Treatment.—Ophthalmia has been almost entirely banished from lying-in hospitals by the routine employment of prophylactic treatment. This consists in bathing the eyelids immediately after the head has escaped from the

vulva with an antiseptic lotion, such as 1 in 4,000 perchloride of mercury, and the subsequent instillation into the conjunctival sac of one or two drops of a 1 per cent. solution of nitrate of silver. The efficacy of silver salts in destroying the gonococcus is well known, and their employment in this connection is of course a prophylactic for this organism only. The vegetable salts of silver, such as argyrol and protargol, are not so efficient in prophylaxis as the nitrate of silver. Owing to the difficulty of efficiently treating ophthalmia in infants, and the serious risks of blindness which attend it, the use of this prophylactic in all suspicious cases is to be advised. Some disadvantages attend the instillation of silver nitrate—viz., a slight conjunctivitis is often set up by the solution, even when there has been no infection, and occasionally keratitis ensues, which may lead to corneal opacities. Routine anti-gonorrhœal prophylaxis is unnecessary in private practice, but it would of course be indicated by direct evidence, or by suspicion of gonorrhœa in the mother.

Active treatment consists chiefly in frequently irrigating the conjunctival sacs with warm saturated boric lotion or saline solution, and the instillation once a day of silver nitrate or protargol solution. The highly infectious nature of the discharge must be borne in mind, and the child must accordingly be put in the charge of a separate nurse, to whom the risk both to herself and others should be fully explained. In severe cases the advice of an ophthalmic surgeon should be obtained.

Icterus Neonatorum.—Jaundice occurs in the new-born child under three different conditions: first, it may be due to the normal hæmolytic changes which occur in the liver and other organs; secondly, it may be due to congenital stenosis of the bile-ducts; thirdly, it may be infective and due to umbilical sepsis or some form of intestinal intoxication. The first variety is unimportant; it is most marked in premature or debilitated infants, and disappears spontaneously without treatment; the urine does not contain bile acids or salts, nor are the stools decolorised. The second and third varieties are almost necessarily fatal; the third is sometimes epidemic in character.

Gastro-intestinal Hæmorrhage: Melæna Neonatorum.—This rare but serious disease of the new-born child probably

occurs in about 1 in 1,000 births. The prominent symptoms are vomiting of blood, and the passage of blood in the stools ; the latter varies in amount from a microscopic quantity up to a steady trickle of blood through the anus. The gravity of the condition is shown by the statistics of Townshend and others, the mortality being approximately 50 per cent.

In many cases the first symptom is hæmatemesis, which may occur before the first feed has been given ; in the majority of cases the initial symptoms appear in the first forty-eight hours ; after the first week very few cases have been recorded. Slight bleeding *per anum* may be overlooked while the meconium is being discharged, unless care is exercised. In many cases the bleeding is not limited to the gastro-intestinal canal, but other mucous surfaces such as the mouth and nose may be affected. Not infrequently subcutaneous ecchymoses also occur. The effect of loss of blood on the young infant is very serious, and in severe cases the child dies of anæmia within two or three days of the commencement of the disease.

The *causation* is obscure, but from a careful clinical study Tyson adduces good reasons for regarding it as septic in origin ; the point of entrance of the organisms may be the cut umbilical cord, or an abrasion on an exposed mucous surface, for example in the mouth or nose. Another possible point of entrance may be the small intestine, in which mucous erosions may be formed by the action of the acid gastric contents when feeding and digestion first begin. A general septic toxæmia is not infrequently associated with bleeding under varied conditions.

The *treatment* consists mainly in supporting the infant's strength with subcutaneous injections of normal saline ; the amount given must be small—1 to 2 ounces—and very careful antiseptic precautions must be observed. Drugs are of little use, but recent attempts at treatment with blood serum are said to have yielded encouraging results. The earliest attempts were made with horse serum, but better effects are shown by serum of blood drawn from the umbilical cord of another child at birth ; the blood of an adult may be used if none other is available. The dose is 10 c.c. repeated three times a day, and if no effect is produced the frequency of the dose may be increased. The serum acts by raising

the coagulability of the infant's blood. Feeding should be limited to the whey-cream mixture.

Infantile Syphilis.—The early recognition of infantile syphilis is of such importance that the matter must be briefly referred to ; for a systematic account a text-book of Diseases of Children should be consulted. A syphilitic infant is often premature, and even when born at term is usually under-sized. The skin is often of a brownish colour, and wrinkled from deficiency of subcutaneous fat ; sometimes, however, the child appears to be quite healthy when born. In a few days some or all of the following signs may appear : (1) skin-cracks (rhagades) at the corners of the mouth ; (2) nasal catarrh (snuffling), which sooner or later is accompanied by a watery discharge ; (3) an eruption on the buttocks, at first dull red and later coppery in colour, and tending to spread in a papular form down the legs ; (4) loss of weight. It must be remembered that simple nasal catarrh from cold often occurs in infants, therefore snuffling does not necessarily indicate syphilis ; and the eruption on the buttocks at first resembles that due to diarrhœa. Any combination of the above conditions justifies careful inquiry for syphilitic taint in the parents, and Wassermann's reaction may be employed to confirm the clinical diagnosis both in the child and the parents. The treatment consists in administering grey powder in doses of half a grain twice or three times a day ; infants tolerate mercury well, and rapid improvement usually follows. The signs of *fœtal* syphilis have been already mentioned.

PART VII

OBSTETRIC OPERATIONS

Artificial Interruption of Pregnancy

IT may be necessary or advisable to interrupt pregnancy either before the fœtus is viable (*induction of abortion*) or after it has become viable (*induction of premature labour*). We shall have to consider first the *indications* for interrupting pregnancy, and then the *methods* by which it may be accomplished.

A. Indications for inducing Abortion or Premature Labour

I. Induction of Abortion.—The indications may be divided into two groups—*general* and *local*.

(A) *General indications.*

(1) Hyperemesis gravidarum.
(2) Acute or chronic nephritis with a history of eclampsia in a previous pregnancy; sometimes bacillus coli urinary infection.
(3) Chronic valvular disease of the heart with failure of compensation.
(4) Advanced pulmonary phthisis.
(5) Insanity.
(6) Chorea when not amenable to general treatment.

(B) *Local indications.*

(1) Incarcerated retroversion, or irreducible prolapse, of the gravid uterus.
(2) Extreme degrees of obstruction, when the alternative of Cæsarean section at term is refused by the patient—*e.g.*:

(*a*) Pelvic contraction of extreme degree (see p. 418).

(*b*) Atresia of the vagina or cervix.
(*c*) Irremovable malignant tumours, such as those of the pelvic bones, and advanced carcinoma of the cervix.

(3) Hydatidiform degeneration of the chorion.
(4) 'Threatened abortion' with uncontrollable hæmorrhage.
(5) Acute hydramnios.
(6) Retention of a dead ovum (occasionally).

Certain of the conditions enumerated above form *absolute* indications for the induction of abortion: these are nephritis, uncompensated valvular lesions of the heart, advanced phthisis, insanity, irremovable malignant tumours, hydatidiform mole, uncontrollable uterine hæmorrhage and acute hydramnios. In the case of the other indications, induction is to be regarded only as the last resort, after the methods of treatment described in previous sections have been found unsuccessful.

Criminal Abortion.—It must be recollected that the induction of abortion, except for clear medical indications, is an offence against the law, and is punishable by imprisonment. It is therefore advisable, before inducing abortion, that a consultation should take place between two medical men, both of whom accept responsibility for what is to be done. Medical men are sometimes requested by married women to induce abortion because pregnancy is inconvenient or motherhood expensive; but for reasons so inadequate as this, the operation should not be performed.

II. **Induction of Premature Labour.**—Labour may be induced prematurely with two distinct objects: (1) to save the mother when urgent complications are present; (2) to enable the fœtus to pass without injury through a relatively or absolutely narrow pelvis.

(A) *General Indications.*—Those already mentioned as indications for inducing abortion will, when encountered in late pregnancy, indicate induction of premature labour. An important addition must be made—viz., *eclampsia*, and the toxæmic state which precedes it in cases where medical treatment has failed; this condition is very seldom met with before the child is viable.

(B) *Local indications.*

(1) Ante-partum hæmorrhage, when profuse or recurrent.
(2) Hydramnios, when attended with severe pressure-symptoms.
(3) Pelvic contraction of moderate degree.
(4) Abnormally large size of fœtus in previous pregnancies.
(5) Premature death of the fœtus *in utero* in previous pregnancies.
(6) Post-maturity. Owing to the large size of the child pregnancy should not be allowed to go beyond 300 days.

Methods of Inducing Abortion and Premature Labour

Many different methods are available for this purpose : the choice of a method is determined partly by the period to which pregnancy has advanced, and partly by the degree of urgency of the indication. Methods required during the earlier months of pregnancy are not suitable for the latter months ; it will therefore be convenient in the first place to consider them in relation to the period of pregnancy.

During the First Three Months of Pregnancy.—During this period of pregnancy induction of abortion may become necessary from hæmorrhage (including hydatidiform degeneration), or from some serious maternal disorder, such as pernicious vomiting, nephritis, or cardiac disease. In all such conditions it is desirable to employ a method by which the uterus can be rapidly emptied ; slow methods of abortion involve increased risks of septic infection, and when serious illness is present more harm to the patient than rapid methods.

The best method is, therefore, rapid dilatation of the cervix under anæsthesia, and immediate evacuation of the uterus. It is not in all cases an easy matter to dilate the cervix of a gravid uterus, and the preliminary use of a laminaria tent may be of considerable assistance. The tent should be introduced at least twelve hours before the operation. Scrupulous attention to antiseptic technique is called for when this appliance is used. The tent is sterilised

by immersion for at least a week in absolute alcohol, or in 1 in 1,000 alcoholic solution of perchloride of mercury. The vulva should be shaved and the vagina and vulva swabbed with an antiseptic solution—*e.g.*, 1 in 4,000 perchloride. A duck-bill speculum is then passed, the cervix seized with a vulsellum, and the tent, held in the introducer, carefully guided into the cervical canal and pushed in for an inch and a half—*i.e.*, until the upper end has passed the internal os. The largest size of tent which it is thought the cervix will take should be selected. The effect of the tent is partially to dilate the cervix, and to soften its tissues so that the subsequent stages of the dilatation can be carried out without laceration.

After the patient has been anæsthetised the tent is removed, and the cervix dilated to the fullest possible extent with the graduated metal dilators shown in Fig. 93. The operator should use sterilised rubber gloves, and the procedure is to be carried out in the same manner and with the same precautions as the gynæcological operation of cervical dilatation. In this manner the cervical canal may be stretched sufficiently to admit the index finger readily. This is quite large enough for the removal of a three months' ovum ; at the fourth or fifth month it may be necessary to enlarge the cervical canal still further in the manner described on the next page.

The dilated cervix being firmly held in the grip of one or two pairs of vulsellum forceps, the index finger is passed into the uterus, the half-hand (fingers only) being introduced for this purpose into the vagina. First the finger is used to detach the ovum from the uterine wall ; the other hand is placed upon the fundus and so used as to push down the uterine wall upon the finger in the cavity, bringing the upper part within reach. The attachments of the ovum at this period are very delicate, and are readily torn through. When the ovum has been *completely* detached the finger is withdrawn and a pair of ovum forceps introduced into the uterus ; some part of the membranes is then seized, and often the entire sac can be gently withdrawn in one piece. The fœtal tissues are very soft at this period, and there is no difficulty in extracting the fœtus in the same manner. Next, the finger should be again introduced and the walls of the uterus

scraped with the finger-tip to detach the decidua vera ; or a flushing curette may be gently used for this purpose. The decidua forms a thick bulky membrane and its complete removal is a matter of considerable importance. Finally, the uterine cavity should be thoroughly irrigated with a hot solution (110° F.) of a non-toxic antiseptic, such as lysol or iodine, which serves the double purpose of arresting hæmorrhage and removing small fragments of loose tissue. Finally, the uterus should be firmly massaged between the fingers in the vagina, and the other hand on the abdomen ; this will squeeze out excess of douche fluid and will cause the uterus to contract strongly, arresting all hæmorrhage. Continuance of undue bleeding is usually due to retention of a piece of membrane or blood-clot, and the finger should be re-introduced into the uterus to detect it. If difficulty is still encountered in arresting hæmorrhage the uterine cavity may be firmly plugged with iodoform or plain sterilised gauze, and an intra-muscular injection of ergot or pituitrin administered. The gauze must be removed within twenty-four hours.

This is the safest and simplest method of terminating an early pregnancy, and no special operative experience is required.

During the Second Three Months of Pregnancy.—During this period the operation required for *rapidly* emptying the uterus is more severe than in the earlier months ; alternative procedures, known as *slow methods*, may be practised, when the indication is not one of urgency.

Rapid Method.—The increased difficulty arises mainly from the size of the fœtus and the greater density of its tissues ; the cervical canal must accordingly be further enlarged to allow it to be extracted.

The operation proceeds in the manner just described up to the point at which the cervix has been dilated to the fullest possible extent with the graduated metal dilators. Further than this the cervix cannot safely be stretched ; serious laceration almost inevitably results from attempts to dilate it further. It is accordingly preferable to incise the cervix in the following manner : The cervix firmly held with two pairs of forceps is pulled down to the vulva and a transverse incision made across it, about two inches in length,

at the level of the cervico-vaginal insertion—*i.e.*, immediately below the bladder (Fig. 292). The bladder is then separated by blunt dissection from the front of the cervix until the peritoneum of the floor of the utero-vesical pouch can be

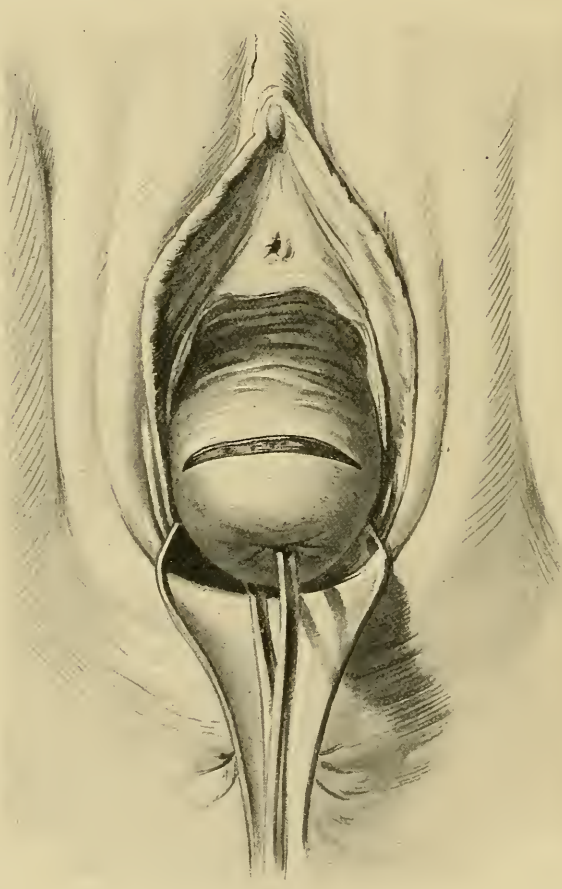


Fig. 292.—The Incision across the front of the Cervix at the level of the Vaginal Insertion.

reached with the finger and recognised by the slippery surfaces gliding over one another (Fig. 293). An incision is then made with strong scissors through the anterior wall of the cervix in the middle line, beginning below and continued

upwards until the internal os has been reached and divided (Fig. 294). By carrying the incision still further upwards the amount of room can be increased according to the requirements of the case. The membranes are now ruptured

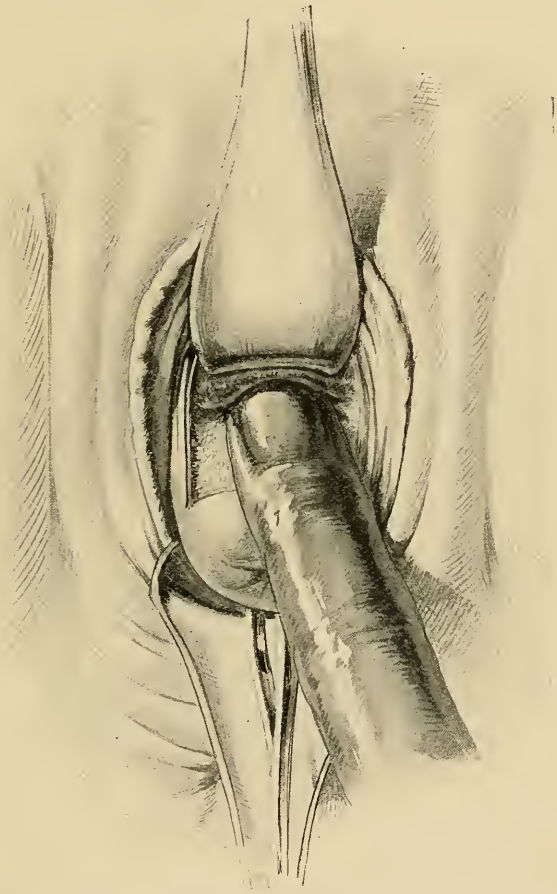


Fig. 293.—Separation of the Bladder from the front of the Cervix to the level of the Utero-vesical Pouch.

and the fœtus seized and extracted by the feet; the head can be perforated if necessary with a knife or scissors. The placenta and membranes can now be detached and removed without difficulty. After the uterine cavity has been douched and bleeding checked in the manner described above, the

incisions are closed with catgut stitches. The uterine incision can be brought well into view by drawing down the cervix with two pairs of vulsellum forceps, while an assistant pushes down the uterus from above. Lastly, the edges of the vaginal incision are closed in the same manner.

This operation is more severe and requires more operative

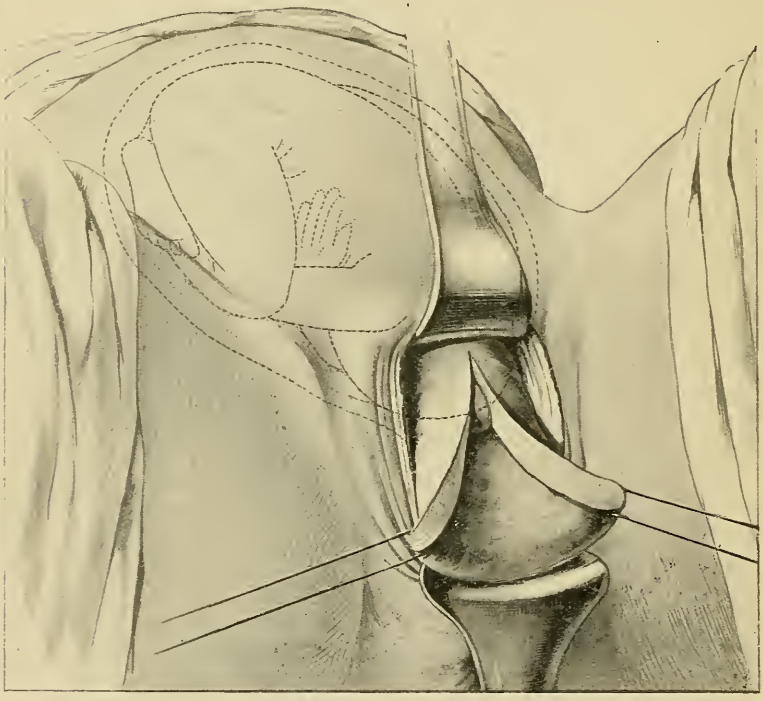


FIG. 294.—Division of the Anterior Wall of the Cervix as high as the level of the Internal Os. The bag of waters is seen bulging through the internal os; the fœtus is represented in outline. (The fœtal outline is too large for the period—three to six months.)

experience than that described above. It is precisely the same procedure as that practised by gynæcologists in removing fibroid polypi too large to pass through the undivided cervical canal.

Slow Methods.—These methods differ from that just described, inasmuch as they aim at exciting the uterus to throw off its contents by a process similar to that of spon-

taneous abortion. It is in many cases exceedingly difficult to excite effective uterine contractions ; considerable delay and repeated manipulations are then required, and in the end some operative procedure may be necessary to terminate the process. Thus the danger of the occurrence of septic infection is much increased.

(1) The membranes may be ruptured by the sound and dilatation begun by the use of a laminaria tent. Rupturing the membranes will not start labour pains unless it leads to a free escape of liquor amnii ; a gradual escape may continue for several days without any sign of labour com-

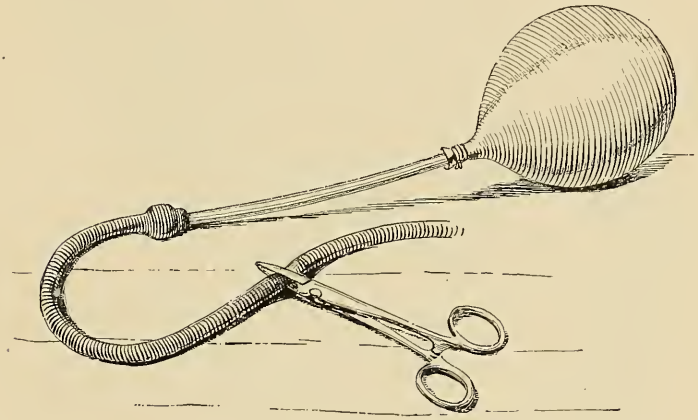


Fig. 295.—Small Hydrostatic Dilator inflated with Fluid.

mencing. Tents are useful in softening the cervical tissues and producing a slight amount of dilatation, but are not effective agents for exciting uterine contractions.

(2) A better method is the use of the small hydrostatic bag shown in Fig. 295 ; if the cervix is completely closed sufficient enlargement can be produced by the preliminary use of a tent, or by using uterine dilators. The instrument consists of a thin rubber bag tied over the end of a gum-elastic catheter. When deflated, it can be pushed through the internal os on the catheter without difficulty. It can be sterilised by boiling before being introduced, and inflated by injecting a measured quantity of sterilised water into it after introduction. It then lies, as shown in Fig. 296,

in the lower pole of the uterine cavity. It is better not to rupture the membranes before using this dilator, as a much more definite increase in intra-uterine tension can then be obtained. The bag acts in the same manner as the larger appliance of Champetier de Ribes (see p. 663). Graduated

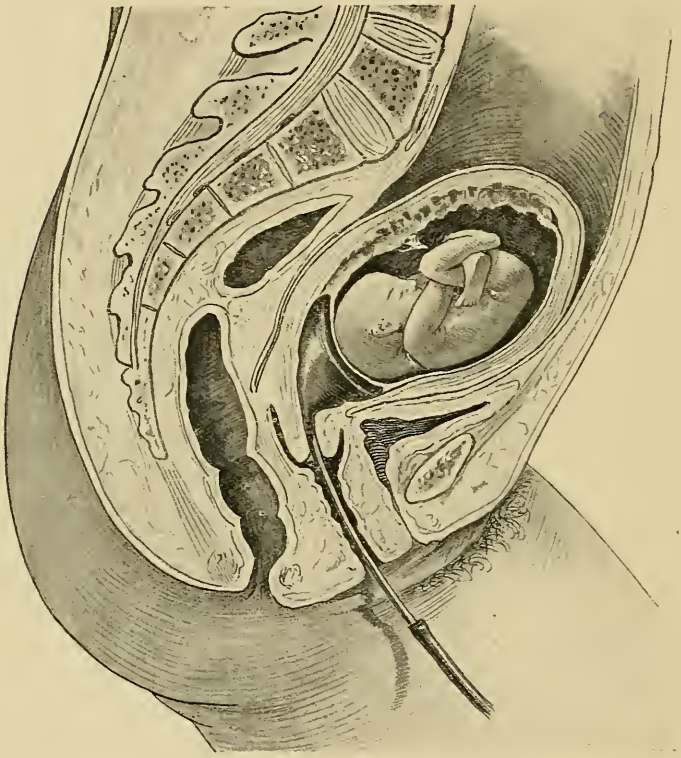


Fig. 296.—The small Hydrostatic Dilator in position in the Uterus.

sizes can be obtained, and when one bag has been expelled as the cervix dilates, another can be introduced.

As soon as regular contractions set in the case may be managed as one of spontaneous abortion.

During the third three months.—During this period the large size of the fœtus and the comparative density of its bony tissues render the evacuation of the uterus a much longer and more complicated process. It is advisable, in

all but cases of the greatest urgency, to proceed by methods designed to excite the process of labour, which is then conducted upon general principles, and in many cases may proceed to a natural termination without further interference. In the presence of maternal complications which admit of no delay, such as eclampsia and certain cases of ante-partum hæmorrhage, forcible methods of rapid delivery *per vaginam* may be adopted (*accouchement forcé*), or the classical operation of Cæsarean section may be practised.

The methods applicable to this period will now be described in turn, and the conditions indicated for which each is suitable.

Rupture of the Membranes.—If this procedure is so carried out as to lead to the escape of a large quantity of liquor amnii, labour follows rapidly as a rule. The slow escape of a small amount of fluid may not provoke labour for several days. Loss of a considerable proportion of the liquor amnii has a very unfavourable influence on the course of labour (see p. 453), while the opening up of the amniotic sac permits of an ascending infection reaching the uterus from the vagina. These two objections have led to other methods being preferred to this one in the majority of cases. In severe instances of hydramnios it is, however, the method of choice, and offers obvious advantages.

Intra-uterine Bougie (Krause's method).—This procedure consists in the introduction of one or more sterilised gum-elastic bougies into the uterus, between the membranes and the uterine wall; it is a very simple method, and requires only care and surgical cleanliness in its performance. The maternal passages must be healthy, and should be previously sterilised, as far as possible, by repeated douching. The observance of strict antiseptic precautions is facilitated by introducing the bougies under anæsthesia. The bougies can be sterilised by boiling them for ten minutes; a convenient plan is to place three or four bougies in a glass catheter tube furnished with a rubber stopper and an outer metal case. The tube containing the bougies is placed unstoppered in a steriliser and boiled along with the rubber stopper. The tube can then be removed, and the rubber stopper inserted with the tube full of the boiled water, without exposing or touching the bougies. In this way sterilised bougies can be

carried in the instrument bag with safety (Fig. 297). Boiling has the practical disadvantage of making the bougies so pliable that it is difficult to introduce them. This may be overcome by using a stilette when passing them. Or, as an alternative to boiling, the bougies may be immersed for an hour in 1 in 500 formalin solution. This solution does not roughen and corrode the gum elastic material as do carbolic acid and the mercurial solutions. The usual size employed is No. 10 or No. 12, but larger sizes up to No. 18 can be used with safety. The introduction of the bougie will be facilitated by placing the patient on her back with the legs acutely flexed—the modified lithotomy position. After disinfection of the vulva and vagina, and the hands, the cervix is exposed with Sim's speculum, seized with vulsellum forceps, and carefully swabbed with tincture of iodine; the point of the bougie is then guided directly into the cervix,

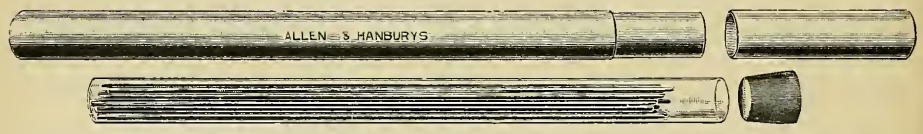


Fig. 297.—Glass Tube, Rubber Stopper, and Metal Case for carrying Sterilised Bougies.

and pushed up to the level of the internal os. The point is then directed towards the uterine wall and the bougie slowly pushed up into the uterus. The length of the bougie which can thus be passed depends of course on the size of the uterus—*i.e.* the period of pregnancy; at or near term only about one inch will remain below the os externum. It is well to introduce a second bougie by the side of the first. The vagina should then be lightly plugged with iodoform gauze. Sometimes a little bleeding occurs indicating that the edge of the placenta has been reached; this does no harm. The bougie is often pushed through the membranes; but when this happens only a moderate amount of liquor amnii escapes if the puncture is above the level of the internal os. If any resistance to the advance of the bougie is met with, the placenta may be in the way or the membranes adherent; the bougie should then be withdrawn, and re-introduced in a different direction.

This procedure invariably provokes labour, but the time

of onset of labour pains is very variable. If the bougie is made to perforate the membranes so that a certain amount of fluid escapes the effect is more rapidly produced. It is in common use at Queen Charlotte's Hospital, where it is found that the average interval between the introduction of the bougie and the delivery of the child is seventy-five hours; occasionally labour may be completed in twelve hours, but cases have now and then occurred in which eight to ten days have elapsed. Even if labour pains do not come on, a little dilatation of the cervix sufficient to admit one or two fingers is usually produced in twenty-four to forty-eight hours. The bougies should not be removed when the pains begin, for this may cause labour to cease; they come away spontaneously with the after-birth. If there is no sign of the commencement of labour in twenty-four hours, another bougie should be introduced at the opposite side; a fourth may be put in after a further twenty-four hours if required. A better plan is to rupture the membranes when the cervix has been softened and dilated sufficiently to introduce two fingers, and introduce the small de Ribes's bag.

Krause's method is simple and easy, and is accordingly well suited for general use. If due attention is paid to surgical cleanliness, bougies may remain for several days in the uterus and no harm will result. They usually become very soft after forty-eight hours' maceration in the uterus. If the membranes are accidentally ruptured during their introduction, it is little if any disadvantage if the opening so made is above the cervix; for the escape of fluid through this valvular opening is slow, and a small bag of waters is formed notwithstanding. The disadvantage of the method is the uncertainty as to when labour will begin effectively.

Hydrostatic Dilators.—Dilatation of the cervix by the introduction into the uterus of rubber or silk bags, and their forcible distension with water, is a method which has been much in vogue for many years. The small bags used for inducing abortion have been already described; only one other need be referred to—viz., that of Champetier de Ribes; the principles upon which its action is based will become clear when the instrument and the method of using it have been described.

De Ribes's dilator is a curved pyriform bag, cylindrical on transverse section, and made of strong silk, covered with indiarubber or gutta-percha (Fig. 298); it is therefore impervious and inelastic, it preserves its shape when distended, and can be sterilised by boiling. The broad upper end measures, when fully distended in the two sizes usually supplied commercially, $4\frac{1}{2}$ inches and $3\frac{1}{2}$ inches in diameter; the curve enables it to lie accurately in the axis of the pelvic canal. When in position the broad end lies in the lower uterine segment, above the level of the pelvic brim, the lower end protrudes from the vulva (Fig. 299). To this end is attached a rubber tube, through which fluid can be pumped

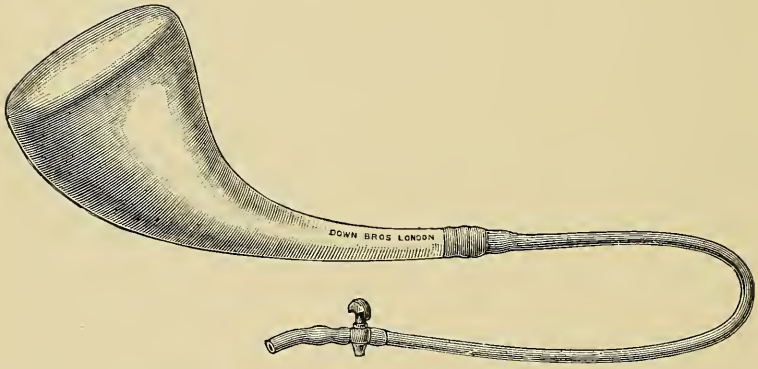


Fig. 298.—Champetier de Ribes's Hydrostatic Bag.

into the bag, and a tap to retain it there. It is not advisable to distend the bag to its utmost capacity with water, as it then becomes very rigid; it is sufficient to introduce into the larger size about fourteen ounces, into the smaller about eleven ounces. It cannot be passed through the undilated cervix; if the cervix admits one finger, the bag can be introduced under an anæsthetic; if it admits two fingers, an anæsthetic is not always required, but it is of advantage in allowing greater attention to antiseptic details. Therefore, when used to induce labour, it may be necessary to dilate the cervix partially by some other method, such as the use of graduated metal dilators, for which an anæsthetic is of course always necessary.

The bag must first be sterilised by boiling for ten minutes;

it should be filled with water and the tap left open before being placed in the steriliser, so that the boiling water can circulate through it and sterilise it both inside and out. Then it is immersed in a solution of 1–4,000 biniodide of mercury if not used immediately. The genital passages must be douched and swabbed, and the operator's hands carefully

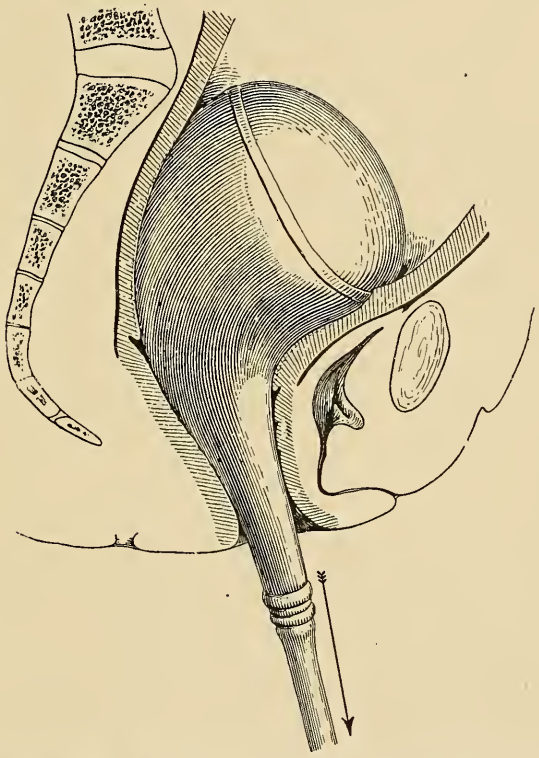


Fig. 299.—De Ribes's Dilator introduced into the Uterus. (Edgar.)

sterilised. The bag is then rolled up into the smallest possible bulk and held in a pair of sterilised forceps ; special forceps may be obtained with curved blades (Fig. 300), but an ordinary pair of ovum forceps will serve the purpose equally well. Two fingers of the left hand are used to guide the forceps into the cervical canal, and the *broad base* of the bag is then pushed up well above the level of the internal os. The forceps is then withdrawn, and boracic lotion (1 in 40),

or boiled water, pumped into the bag with a syringe ; the capacity of the bag should have been previously measured, and a quantity of fluid less than that required to fill it entirely should be injected. If the bag has not been pushed far enough into the cervix, it will escape into the vagina as it becomes distended ; if the broad end lies above the internal os, its shape will prevent its escape in this manner.

De Ribes's bag, as a rule, is introduced between the membranes and the uterine wall ; when distended it therefore causes extensive separation of the membranes from the wall of the lower uterine segment. If, however, while introducing it the membranes should be accidentally ruptured, no harm will follow, for the distended bag prevents escape of the liquor amnii. An important exception to this rule is the case of placenta prævia ; here the membranes

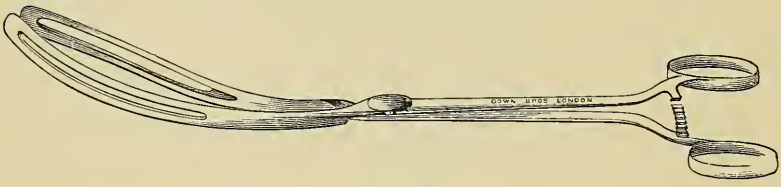


Fig. 300.—De Ribes's Forceps.

should first be ruptured and the bag then introduced into the amniotic sac, otherwise distension of the bag will cause extensive separation of the placenta, which not only increases the risk of hæmorrhage, but also prejudices the survival of the child by diminishing its sources of aeration and nutrition.

The normal mechanism of labour is closely imitated by the action of de Ribes's bag. Its curved conical shape corresponds to the shape of the dilating cervix and lower uterine segment, while its fluid consistence resembles that of the normal dilator—the bag of waters. When the membranes have ruptured, escape of liquor amnii is prevented by it. Its action depends upon its exciting uterine contractions, by which it is driven gradually down through the cervix, distending it as it passes. When the pains excited by it are feeble, dilatation can be assisted by traction on the lower end of the bag. Traction may be applied intermittently by pulling during the pains, or continuously by

attaching a weight of two to four pounds to the end of the rubber tube and carrying it over the foot of the bed. Ultimately the whole cervical canal is stretched to the diameter of the broad end, and any intra-uterine manipulation required to deliver the child can therefore be immediately undertaken. When the broad end has been driven out of the cervix the contents may be allowed to escape and the bag is then withdrawn. Often the uterine pains excited by it are so strong that natural delivery is quickly effected after dilatation, when the pelvis is of normal size. Sometimes, however, the pains rapidly cease when the dilator has been expelled into the vagina. In some rare cases pains are not excited by the bag at all, although with the help of traction it may dilate the cervix.

The time occupied by this method in fully dilating the cervix varies; when employed to excite labour it takes, on an average, from twelve to twenty-four hours to obtain full dilatation; if labour is already in progress dilatation may be completed by its use in from half an hour to two hours.

Two objections to the use of de Ribes's bag must be noticed. In the first place, there is no doubt that its presence in the lower uterine segment displaces the presenting part and may thus disturb a favourable presentation. This objection is, however, unimportant, for after the bag has done its work the condition of the passages allows of the easy correction of any unfavourable presentation. The occasional occurrence of rupture of the uterus when the bag has been used in cases of placenta prævia has been already referred to.

In inducing premature labour with de Ribes's bag the larger size is usually unnecessary; and it must be recollected that when the pelvic brim is much contracted there will not be room in the conjugate for the larger size. De Ribes's bag is too large to be used for the induction of abortion, the small rubber bags previously described being preferable for this purpose.

Dilatation by Branched Metal Dilators.—This method, introduced by Bossi in 1887, has been described in previous editions, but extended experience of its use has been unfavourable, and it is now regarded as too dan-

gerous for general use. No description of it need therefore be given.

Digital Dilatation of the Cervix.—When the cervix is sufficiently dilated to admit one or two fingers, full dilatation may be produced by digital stretching. The greatest attention must be paid to antiseptic technique, sterilised rubber gloves being worn by the operator, and the vulva and vaginal canal being thoroughly cleansed and swabbed with antiseptic solutions. The thumb and index finger of one hand are first inserted, and the cervix stretched as far as possible by separating them. Then the remaining fingers are successively introduced, until all the fingers of the hand can be passed through the internal os; this involves the passage of the entire hand into the vagina. Another method in which both hands are employed is also used; after two fingers of one hand have been passed, the corresponding fingers of the other hand are introduced, and the cervix stretched by separating the fingers of the two hands.

This method requires an anæsthetic, careful antiseptic precautions, and the exercise of gentleness and great patience in its performance; even then very serious lacerations of the vaginal vault or of the cervix running up into the lower segment, and even complete rupture of the uterine wall, may occur, for it is impossible to graduate the amount of force applied in this manner. It is consequently not to be recommended as a method of inducing labour, but it may safely and conveniently be employed under anæsthesia to complete dilatation in cases of prolonged first stage when the cervix is already at least one-half dilated.

Vaginal Cæsarean Section.—This operation consists in deeply incising the cervix so as to allow of the immediate delivery of the child through the natural passages. Although anticipated by French obstetricians of the eighteenth century, the operation here described is of quite recent date, and was introduced in 1896 by Dührssen.

The operation is performed as follows by Bumm. The cervix is first exposed by two specula, then seized with two pairs of vulsellum forceps, and pulled down to the level of the ostium vaginæ. A median incision is then made, commencing on the anterior lip of the os externum, and passing over the cervix and forwards on to the anterior vaginal

wall to a point two inches above the urinary meatus. Through this incision the bladder is separated from the uterine and vaginal walls by blunt dissection. The peritoneum of the utero-vesical pouch is pushed up, but is not incised. A median incision is then made in the anterior wall of the cervix and carried upwards to the level of the internal os; the cervix can be pulled down lower and lower during the process so as to keep the whole incision well within view. When the internal os has been incised the bag of membranes will present. Dührssen recommends that when the fœtus is at term the posterior fornix should be similarly incised and the posterior cervical wall divided up to a corresponding level. The uterine incision is carried a little above the internal os, and then the membranes are ruptured, and delivery effected by podalic version. The uterine incision measures about 4 inches, so that it involves both cervix and lower uterine segment. After delivery of the placenta, the cervix is again pulled down to the vulva and the deep incision closed with interrupted catgut sutures from above downwards. Finally the incision in the vaginal wall is similarly closed.

This operation is difficult in a primigravida on account of the small size of the vagina and the rigidity of the perineum. It cannot be performed unless the maternal pelvis is of normal size, and up to the present time it has been chiefly applied to cases of eclampsia in which it was desired to deliver rapidly. The mortality is high, but it must be recollected that the maternal conditions for which it is undertaken are very grave. There is no doubt that at or near term the operation is one of much greater difficulty than the classical Cæsarean section, and it is very doubtful whether it has any advantages which compensate for these technical difficulties. If pregnancy has not exceeded the twenty-eighth week, and the patient is a multipara the operation is comparatively simple.

By Munro Kerr and other writers the operation of division of the cervix to facilitate evacuation of the uterus in the middle three months of pregnancy is also called Vaginal Cæsarean Section. But in earlier pregnancy the procedure, though similar in principle, is characterised by great simplicity, while in the case of a viable child it becomes a formidable operation, requiring special technical skill. It is an

innovation to apply the term Cæsarean Section to incision of the uterus at a time when the child is non-viable, and it is better to restrict the name of Vaginal Cæsarean Section to the operation just described.

Accouchement forcé.—This procedure is defined by Munro Kerr as 'rapid and forcible enlargement of the cervical canal and immediate extraction of the child.' It therefore includes the methods of digital dilatation, dilatation with the branched dilatators of Bossi, &c., and vaginal Cæsarean section. These are all operations of great gravity, and are attended by risks of serious injury to the maternal passages, and a correspondingly high maternal mortality. Further, they cannot be made use of when pelvic contraction is present, if it is desired also to save the life of the child. By British obstetricians these methods are seldom employed. Cases in which the immediate evacuation of the uterus becomes necessary owing to some urgent maternal complication are by preference dealt with by the classical operation of Cæsarean section. In comparison with the procedures classed under *Accouchement forcé*, Cæsarean section is simpler, requires less technical skill, is equally expeditious, and is applicable to all conditions.

General Considerations.—Slow methods of induction are suitable for non-urgent indications, such as pelvic contraction, albuminuria and nephritis, chorea, heart disease, &c. Cases of ante-partum hæmorrhage, with the exception of the concealed accidental form, may also be dealt with by these methods. The simplest is the intra-uterine bougie method of Krause; the sole disadvantage attending it is the delay which often occurs in the establishment of effective uterine contractions. This delay may be greatly shortened by removing the bougies and introducing the smaller de Ribes's bag as soon as sufficient dilatation of the cervix to allow of this being easily done is produced; this usually occurs in twenty-four to forty-eight hours, even if labour is not actually excited.

De Ribes's bag is the best method to employ to provoke labour in cases of placenta prævia; if the cervix is insufficiently dilated the small hydrostatic dilator (Fig. 295) may first be used, in order to produce sufficient dilatation to allow of the introduction of the larger bag.

Version : Turning.

Version consists in altering the presentation of the fœtus in the uterus ; this may be done in order to correct an unfavourable presentation, or for other purposes which will be referred to below. As a rule the breech is made to present (*podalic version*), sometimes, however, it is the head (*cephalic version*). The conditions under which it may be desirable to change the presentation are various, and this is true also of the purposes which it is intended to effect.

(1) In transverse cases it is essential that the presentation should be changed (see p. 382) ; before labour, cephalic version is to be recommended ; during labour, podalic version, followed by pulling down a leg.

(2) In breech presentations seen before labour or early in labour cephalic version should be performed if the patient is a primipara.

(3) In brow presentations seen early in labour podalic version is indicated.

(4) In placenta prævia podalic version is extensively employed, partly as a means of immediately controlling hæmorrhage, partly to expedite delivery.

(5) In prolapse of the cord podalic version may be performed if the head is not engaged, to relieve the cord from the risk of compression by the head.

(6) In cases of pelvic contraction of the flat variety and of medium degree, prophylactic podalic version may be employed, as some authorities believe that the passage of the after-coming head is easier in this kind of pelvis than the fore-coming head.

(7) When the cervix is three-fourths dilated and the pelvis of normal size, podalic version may be practised as a method of immediate delivery when this is indicated by maternal complications or by fœtal distress.

Version may be performed by external (abdominal) manipulations alone, by internal manipulations alone, or by combined internal and external manipulations ; these methods are respectively termed *external*, *internal*, and *combined* or *bi-polar version*.

External Version.—The fœtus *in utero* can be turned by abdominal manipulation if there is a sufficiency of liquor

amnii, if the uterus is not contracting frequently and powerfully, and if the abdominal walls are lax. The time for its performance is therefore before labour sets in, or very early in labour ; it is much easier in a multipara than in a primigravida. Full surgical anæsthesia is required if strong and frequent labour pains are present. It is the method of choice in all cases of transverse presentation seen before labour ;

Fig. 301.—External Version in Breech Presentation. First Stage. The hands are locating the position of the head ; the head and breech are to be pushed aside in opposite directions, as shown by the arrows.

it is also useful in breech presentations occurring in a primipara and first seen before labour. In both of these instances cephalic version should be performed—*i.e.* the head should be made to present. It may also be made use of in placenta prævia at the beginning of the first stage, as a preliminary to pulling down a leg into the cervix.

(*a*) *Head or Breech Presentation.*—The patient should lie on her back with the shoulders slightly raised and the knees

flexed, the abdomen being completely uncovered. The position of the head should first be located ; it will usually be found in a breech presentation distinctly to one side of the mid-line (Fig. 301). The breech will be found as a rule lying above the brim ; if labour is in progress and the membranes have ruptured it may be engaged.

The *first stage* consists in applying pressure to the head and to the breech with the hand in opposite directions, so as

Fig. 302.—*External Version.* The presentation is transverse, the first stage having been completed.

to push the head down towards the pelvis and the breech upwards upon the opposite side of the uterus towards the fundus (Fig. 301). The effect of this movement is to make the presentation transverse. If the abdominal walls are lax as in a multipara, and the patient is not in labour, this stage is very readily carried out ; in the case of a primipara, if labour is in progress, considerable difficulty may be encountered, and it may be necessary to give an anæsthetic.

The *second stage* continues the movement begun in the

first until the head has been brought over the pelvic brim and the breech pushed up to the fundus (Fig. 303). The head must now be carefully adjusted in the brim and the long axis of the fœtal trunk made to correspond with the long axis of the uterus. Unless this point receives careful attention recurrence of the displacement will almost certainly take place.

The *third stage* consists first in pushing the head down into the brim as low as possible by grasping it with the two hands (Fig. 304). Finally, steady pressure is made upon the fundus

Fig. 303.—*External Version.* Second Stage. The lie of the fœtus has been made longitudinal and the head is being adjusted over the pelvic brim, while the breech is being pushed into the mid-line at the fundus.

so as to push the whole fœtal body as low down in the abdomen as possible. This has the effect of flexing the spine and the head, the object being to restore the normal attitude of general flexion as nearly as possible, for this attitude may have been disturbed by the previous manipulations.

Transverse Presentation.—When a transverse presentation is met with, the possibility of the pelvis being contracted must always be borne in mind, and careful measurements must be taken. If the degree of contraction is compatible with delivery *per vaginam*, podalic version may be performed if the pelvis is flattened. The position of the

head should be carefully located, and the operation is then performed in the manner above described, except that the head is pushed upwards.

After correction by external version the original presentation is apt to recur. In transverse presentations and in placenta prævia podalic is preferable to cephalic version, and if labour has begun the membranes may be ruptured and a foot pulled down into the vagina. This effectually prevents

FIG. 304.—*External Version.* Third Stage. The head is being pushed down into the pelvic brim, a vertex presentation having been produced.

recurrence of the displacement. If cephalic version has been performed for breech presentation before labour, great difficulty may be encountered in keeping the head in the pelvis, and the operation may have to be repeated. If labour has begun, a thickly folded towel may be laid on each side of the uterus and a tight binder applied over all, to assist in maintaining the corrected presentation.

Internal Version.—This operation consists in introducing the hand into the uterine cavity, seizing the feet and turning the child so as to bring down the pelvic extremity ; under

urgent conditions this is followed by immediate extraction, but if the circumstances permit, time should be allowed for natural delivery to take place as in the management of a breech labour. Internal version is a very old obstetric pro-

Fig. 305.—Effect of seizing the Lower Leg in turning a Transverse Presentation; the back is rotated to the front. (Farabœuf and Varnier.)

cedure, and was described and practised by Hippocrates; later writers upon obstetrics also have practically all described it (Celsus, Galen, Ambroise Paré, Baudelocque, Smellie), so that it has probably been in unbroken use for two thousand years. The earlier records of the operation show that it was then used to bring down the head (cephalic

version) ; within recent times it has been employed only as a method of podalic version. This method of version differs from the others in providing not only for changing the presentation, but also for immediately delivering the child.

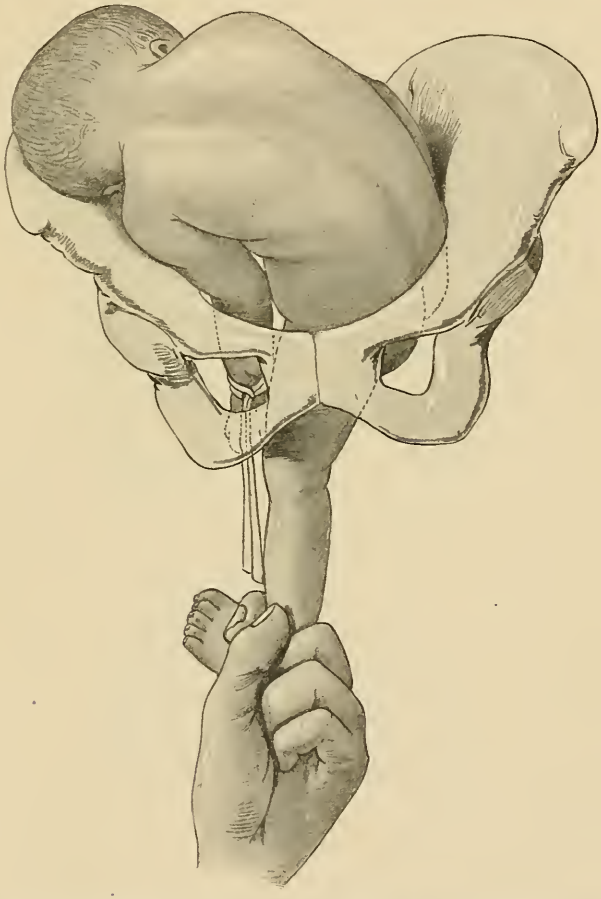


Fig. 306.—Effect of seizing the Lower Leg in turning a Transverse Presentation. (Farabœuf and Varnier.)

The operation is by no means devoid of risk, and should not be performed except under perfectly clear indications. It is absolutely contra-indicated by tonic uterine contraction ; and whenever some time has elapsed since rupture of the membranes it should not be attempted unless the mobility

of the fœtus is good, and the hand can be introduced without force into the uterus. When the fœtus is dead, craniotomy should always be preferred. Unless the conjugate diameter of the pelvic brim measures at least $3\frac{1}{2}$ inches, version is an unsuitable method of delivering a living child in a flat pelvis,

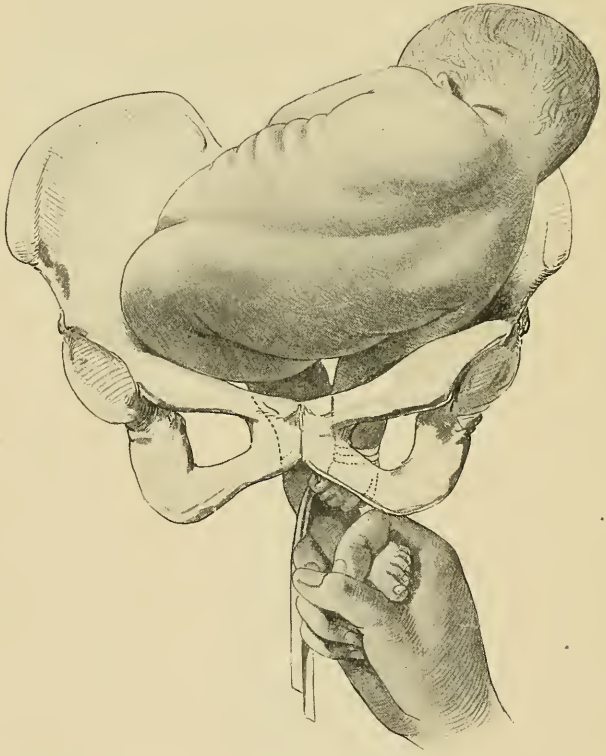


Fig. 307.—Effect of seizing the Upper Leg in turning a Transverse Presentation ; the back is rotated posteriorly. (Farabœuf and Varnier.)

and in all degrees of generally contracted pelvis it should be avoided. The strictest antiseptic precautions are called for, and the manipulations must be carried out with gentleness and deliberation ; only in this way can the risks of sepsis and rupture of the uterus be reduced to a minimum. The most favourable moment for performance of the operation is when the cervix is about three-fourths dilated and the membranes

are unruptured ; but, when half dilated, the cervix can first be stretched to the required extent by the digital method, under anæsthesia.

The most important part of the procedure consists in

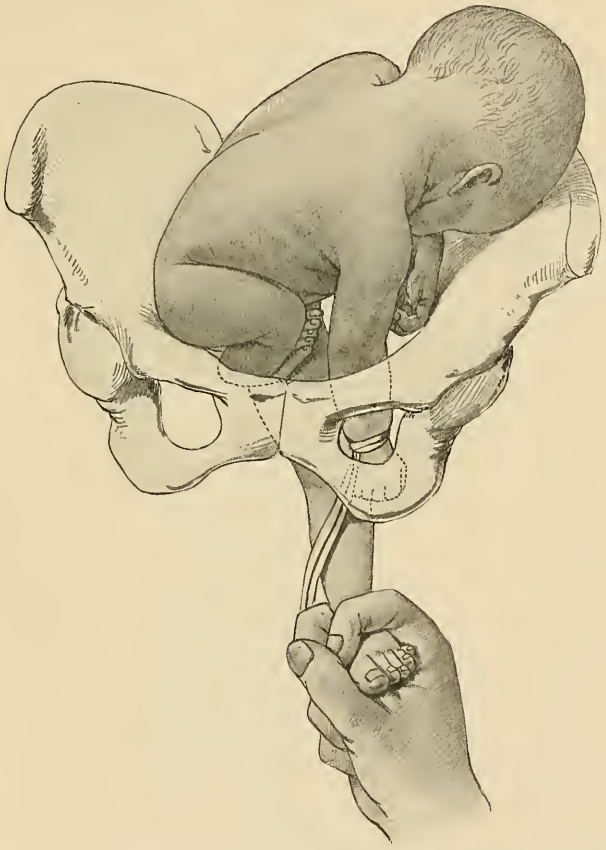


Fig. 308.—Effect of seizing the Upper Leg in turning a Transverse Presentation. (Farabœuf and Varnier.)

seizing and pulling down a foot ; it is usually better to pull down one foot only and complete the extraction as a half breech. In cases where rapidity is desired both feet may be pulled down at the same time, or the second may be sought for after the first has been pulled down.

The first point requiring attention is that the hand should

not be mistaken for the foot. The great mobility of the thumb is of course distinctive of the hand; but it is not always easy to recognise this when, for example, the limb

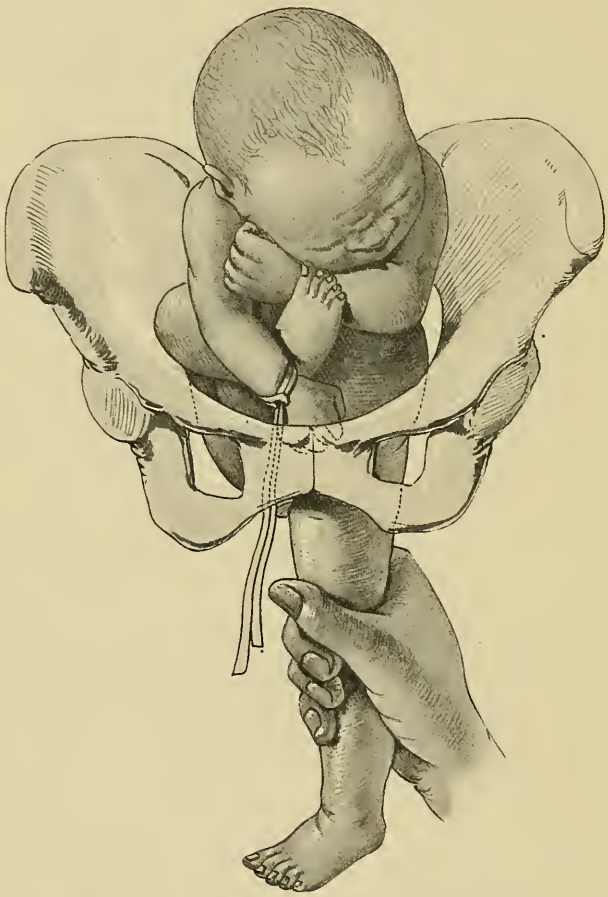


Fig. 309.—Effect of seizing the Upper Leg in turning a Transverse Presentation. (Farabœuf and Varnier.)

can only be reached with the finger tips. As Munro Kerr has pointed out, the most distinctive part of the foot is the heel, which can be recognised by one finger, and serves absolutely to distinguish it from the hand. If this point cannot be made out, the fingers should be passed up to the

buttocks and drawn down the thigh and leg until the foot is reached.

The next point is the choice of a foot, which is important, inasmuch as although either will do, extraction is greatly facilitated by selecting the proper foot. The principle governing the choice is that that foot should be seized which, when drawn down, will cause the back of the child to rotate forwards; if the wrong one is seized the back will rotate backwards. The rule is that in transverse presentations, when the position is dorso-anterior, the lower foot should be pulled down, when dorso-posterior, the upper foot. From Figures 305 to 309 it will be seen that the direction in which the trunk rotates is controlled by the choice of a foot when one only is pulled down. As the delivery of a breech presentation is much easier when anterior rotation of the back occurs, it is important that the proper foot should be pulled down. In head presentations the choice of a foot is unimportant, as dorso-anterior positions necessarily become dorso-posterior after turning. In seeking the proper foot it must be recollected that in the normal fœtal attitude the legs are often crossed; in a transverse presentation it accordingly follows that the foot first encountered is not necessarily that of the lower limb. In order to be sure the fingers must be passed up to the buttocks and the desired foot found by following down the thigh.

Preliminaries.—An anæsthetic should always be administered, for should the patient move unexpectedly while the operator's hand is in the uterus the risks of rupture are considerable. The bladder should be emptied by catheter. The position of the back and head of the child should be carefully localised by abdominal and vaginal examination, and the fœtal heart auscultated. The approximate size of the pelvis and of the fœtus must also be estimated. The patient may be placed in either the lithotomy position or the ordinary lateral posture; in the latter less assistance is required by the operator. The operator, after carefully disinfecting his hands and forearms, should put on a pair of previously boiled rubber gloves; the vulva should be shaved, and the vulva and vagina cleansed with soap, and then swabbed with an antiseptic solution (biniodide of mercury 1 in 1,000, or lysol ʒj. to Oj.).

Steps of the Operation.—(*a*) *When the presentation is transverse.*—When the head lies to the right the patient should be placed on her left side, with the buttocks over the edge of the bed, the operator using his right hand for the internal manipulations, as this hand can be more easily directed to the left side of the uterus where the feet are lying (Fig. 310). When the head lies to the left side, the patient

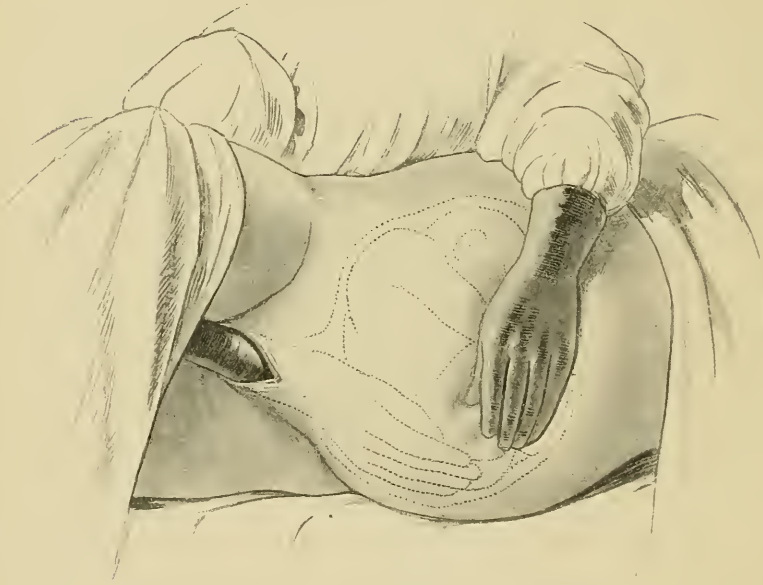


Fig. 310.—Internal Version for Transverse Presentation; introducing the hand into the uterus. (After Nagel.)

should be placed on her right, the operator using his left hand.

(1) The hand should be passed into the vulva with the fingers and thumb bent into the shape of a cone (Fig. 258); the direction to be taken is at first upwards and backwards (axis of outlet), gradually changing to upwards and forwards (axis of brim).

(2) The hand should not enter the uterus until the strong contractions and expulsive efforts excited by its introduction into the vagina have passed away.

(3) In dorso-anterior positions the hand should follow

the curve of the lower buttock and thigh until the *lower* foot can be reached, the external hand raising the pelvic pole of the fœtus so as to render it more accessible (Fig. 311).

(4) In dorso-posterior positions the hand should be passed over the ventral aspect of the fœtus, so as to reach the *upper* foot, aided by the external hand. The effect of seizing the upper foot will be to rotate the trunk so as to

Fig. 311.—Internal Version for Transverse Presentation ; seizing the lower foot. (After Nagel.)

bring the back forwards and convert the presentation into an anterior breech.

(5) When the foot has been seized, it should be drawn gently down into the vagina, the head being at the same time pushed up towards the fundus by the external hand or by an assistant (Fig. 312). The patient may now be placed in the dorsal position (as in the figure), or delivery may be completed without change of position. Extraction is usually easier in the dorsal position.

(6) These manipulations should as far as possible be made during the intervals of the contractions, the internal hand making no advance during the pains, but being held flattened over the body of the child.

(7) The next step is the extraction of the child. This

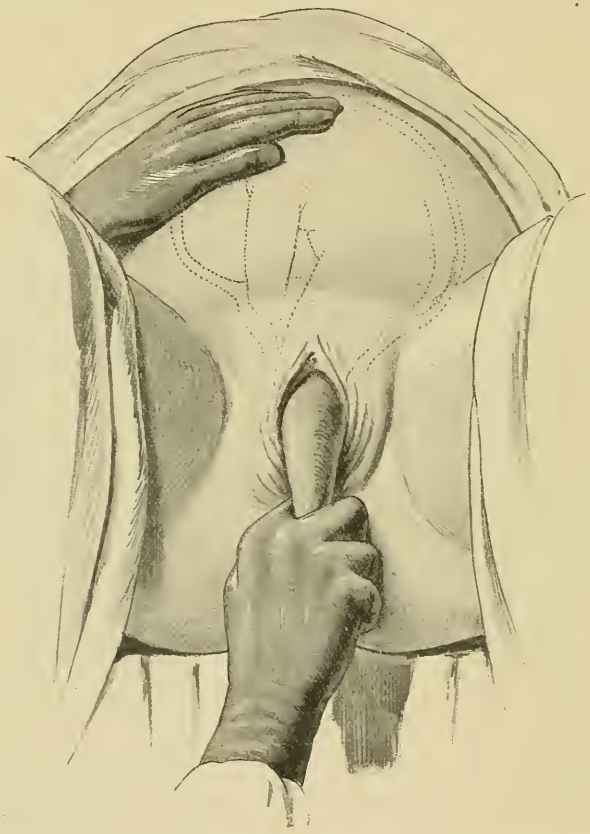


Fig. 312.—Internal Version; pulling the leg down through the vulva, and pushing the head upwards with the other hand. (After Nagel.)

must be carried out in the manner already described in the management of a breech labour (see p. 368). The risks of the arms becoming extended are great, for the attitude of the fœtus is necessarily disturbed in turning. Sometimes in transverse cases an arm may be found prolapsed before

version has been commenced. A loop of gauze bandage should then be passed over the wrist, and sufficient traction made upon it to prevent this arm from being carried up into the uterus as the child's body is turned. If the other arm should become extended it will be brought down much more easily than if both were extended. Steady pressure on the fundus should be kept up by an assistant during extraction.

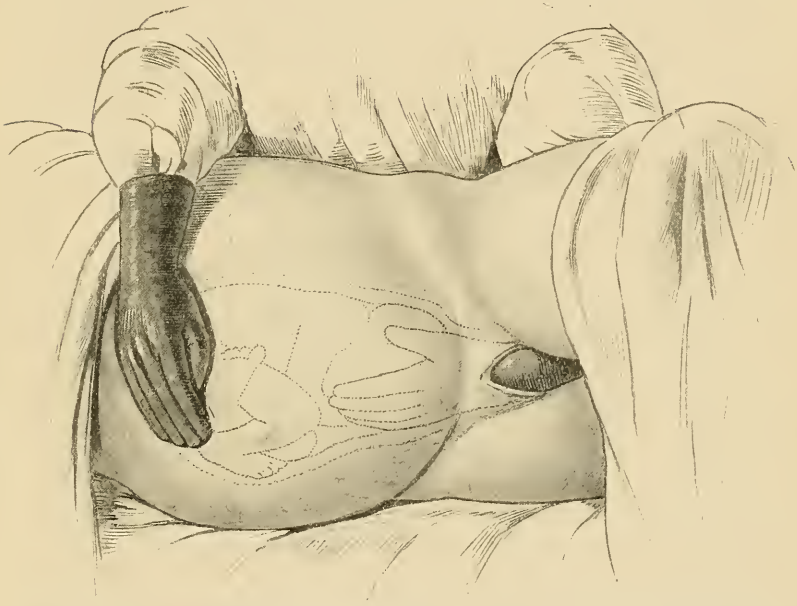


Fig. 313.—Internal Version for Vertex Presentation ; introducing the hand into the uterus. (After Nagel.)

(8) After the delivery of the after-birth an antiseptic intra-uterine douche should always be given.

(9) Owing to the risks of fœtal asphyxia, preparations for the resuscitation of the infant should be made.

(*b*) *When the head presents.*—In non-engagement of the head in the pelvic brim, prolapse of the cord, in cases of ante-partum hæmorrhage, or in presentation of the face or brow, internal version of a head presentation during labour is sometimes called for. Whenever possible it is preferable to turn by the external method, and then pull down the legs (p. 501). When the back lies to the right the patient

should be placed upon her left side, the operator using his right hand ; when the back lies to the left, she should be placed upon her right side, the operator using his left hand (Fig. 313). The steps of the operation are the same as in a transverse presentation, the hand being always passed along the ventral aspect of the fœtus ; it does not matter in this case which foot is seized in turning. When the hand enters the uterus the head is necessarily pushed to one side, thus facilitating its displacement upwards by the external hand later on. It is more difficult to turn a head than a transverse presentation, as the long axis of the fœtus must be made to cross the transverse axis of the uterus. It follows that this method of delivery in head presentation must not be attempted unless the conditions are quite favourable—and sufficient liquor amnii remains in the uterus to allow free mobility to the presenting part.

Difficulties in Performing Internal Version.—Under favourable conditions internal version is a simple and an easy operation ; but the extraction of the child after it has been turned may be complicated by the arms becoming extended. When the membranes have been ruptured for some time and the amount of liquor amnii remaining in the uterus is small, turning is both difficult and dangerous. It is sometimes difficult to decide whether, in a given case, it is safe to make the attempt or not. These difficulties are most often encountered in transverse presentations when the child is still alive. The presence of a well-marked retraction ring always contra-indicates any attempt at version ; when the natural intermittent character of the uterine contractions has been lost, or the uterus does not become properly relaxed during the intervals, the introduction of the hand, even under full anæsthesia, excites violent expulsive efforts which greatly impede the manipulations and increase the risks of rupture. Unless the operator has had some previous experience of turning, he should not make the attempt when the conditions are not in all respects favourable.

The *risks* which attend internal version are clearly defined. First, there is the risk of *sepsis ;* even if the hand of the operator is protected by a sterilised rubber glove, the danger of carrying infective material from the vulva into the uterus remains. It is therefore important

that special precautions should be taken, the vulva being shaved, and both vulva and vagina carefully cleansed with soap, followed by lysol or biniodide of mercury. Douching alone is quite inadequate. Secondly, there is the risk of *rupture of the uterus*, but except in the cases of difficulty just referred to, this risk is remote. Thirdly, version having been begun and the fœtus partially turned, it may be found impossible to complete the operation owing to powerful and continuous retraction of the uterus. Fourthly, version having been completed, difficulty in extracting the after-coming head and arms may be met with, resulting in the death of the child from asphyxia, or in injury to its limbs.

Combined or Bi-polar Version. (Method of Braxton Hicks.)—During the first stage of labour, when the cervix is sufficiently dilated to admit one or two fingers, and the membranes are unruptured, or if ruptured, a large amount of liquor amnii remains, it is possible to turn without introducing the hand into the uterus. It is evident that in internal version both external and internal manipulations are employed, and both poles of the fœtus are displaced ; it might therefore also be accurately called combined or bi-polar version. The essential difference between internal version and the method now to be described is that, as in the latter the whole hand is not introduced into the uterus, it can be performed at an earlier stage of labour. It is not frequently performed, for it is more difficult than either of the other methods, special difficulty being met with in carrying the long axis of the fœtus through the transverse axis of the uterus. In transverse it is easier than in vertex presentations. Bi-polar version is only used to produce a breech presentation.

Preliminaries.—These are the same as for internal version ; an anæsthetic, though not essential, is of great assistance.

Steps. (*a*) *When the presentation is transverse.*—Either hand may be employed for the internal manipulations, the patient being in the dorsal or left lateral position.

(1) The position of the head having been located, the presenting shoulder is pushed upwards out of the brim, and *towards the side where the head lies ;* the external hand

assists by pushing the head upwards towards the hypochondrium.

(2) The arm or some part of the trunk now lies over the internal os, and is pushed into the iliac fossa on the same side, the head being simultaneously displaced upwards and towards the middle line into the epigastric region.

(3) The breech or lower limbs now come within reach of the internal fingers; the membranes are then ruptured, and one foot pulled down into the vagina, while the head is pushed up to the fundus. The case is then managed as a breech labour, delivery being left to nature.

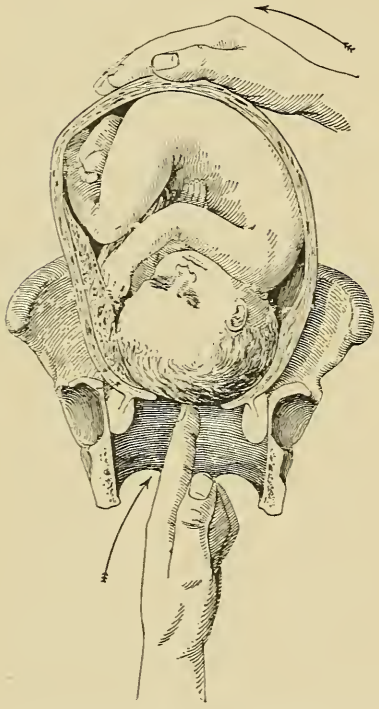


Fig. 314.—Bi-polar Version: First Step in Head Presentation. Placenta Prævia. (Braxton Hicks.)

(*b*) *When the head presents.*—(1) The head is pushed upwards out of the brim, and then into the iliac fossa *on the side to which the back of the fœtus lies* (Fig. 314); at the same time the breech is displaced downwards and to the opposite side.

(2) The presentation has now become transverse, or oblique, and the operation is completed in the manner just described.

It is seldom necessary to adopt this difficult method of version. Under most circumstances when it could be made use of it will be found easier to turn by the external method, and having thus brought down the breech into the brim, to pass two fingers into the cervix, rupture the membranes and pull down a leg. When in cases of placenta prævia it is desired to turn, external podalic version followed by immediate pulling down of a leg is preferable to the method of

Braxton Hicks, inasmuch as it reduces the internal manipulations to a minimum.

Obstetric Forceps

The construction of the modern obstetric forceps will be best understood by tracing the various phases through which the instrument has passed in its evolution.

The earliest forceps to be publicly described was that of Palfyn, a surgeon of the city of Ghent, in 1720. It consisted

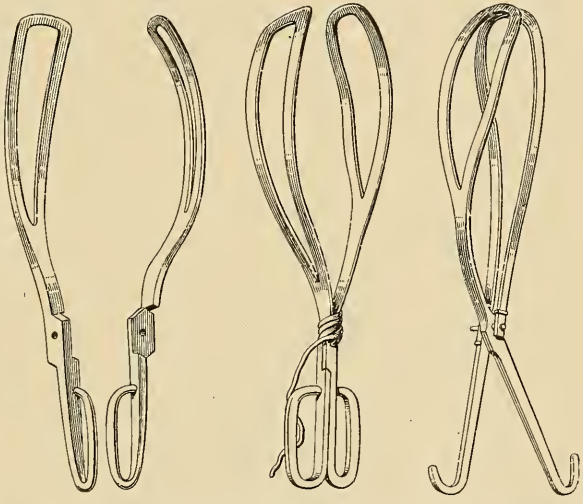


Fig. 315.—Different Patterns of Chamberlen's Forceps.

of a pair of spoon-shaped blades with wooden handles ; the blades were applied to the sides of the head, and the handles tied firmly together so that the instrument could be used for traction. Before this period (seventeenth century), an instrument had been used in London by a family of doctors, including at least three generations, named Chamberlen ; the construction of their forceps was, however, maintained as a strict family secret, and not until long after the death of the last of their line did the secret leak out. In 1813 the three forceps represented in Fig. 315 were found by accident in an old chest in a house which one hundred years previously had belonged to the Chamberlens, and are believed to be the

instruments with which they worked. These three forceps were distinctly better than Palfyn's; they consisted of a pair of metal, spoon-shaped, fenestrated blades, united like

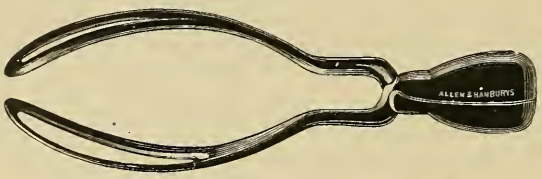


FIG. 316.—Short or Straight Forceps.

a pair of scissors with a pin-joint, and having curved scissors-handles; slight modifications in shape appear in the three forms, and in one a tape threaded through and around the blades replaces the pin-joint. They are composed of three

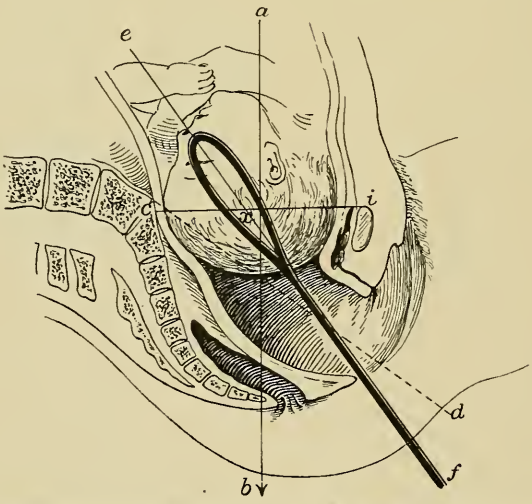


FIG. 317.—Straight Forceps applied to the Head at the Brim (Schematic). (Milne Murray.)

a, *b*. Axis of pelvic brim. *c*, *i*. Plane of pelvic brim. *c*, *d*. Axis of pelvic outlet. *e*, *x*, *f*. Direction of traction made by forceps.

parts: (1) the curved blade, (2) the lock or joint, and (3) the handle; the curve, being designed to adapt the blades to the fœtal head, is known as the *fœtal* or *cephalic curve*. This is the only curve upon these early instruments; viewed in profile, they are straight from end to end.

A forceps constructed upon this principle, and called the *short* or *straight forceps*, was used for some purposes until

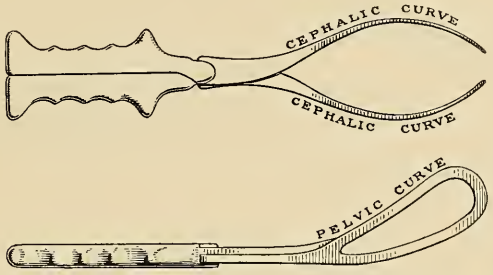


FIG. 318.—Obstetric Forceps, showing the Cephalic and Pelvic Curves. (Edgar.)

comparatively recent years, but has now been generally abandoned (Fig. 316).

The faults of this forceps are easily demonstrated. The instrument is straight, but the pelvic canal, in which it has to lie, is curved ; therefore, in grasping the fœtal head *at the brim*, a central grip cannot be obtained, for the instrument will seize the part of the head which lies behind the centre (Fig. 317). In occipito-anterior positions, traction thus applied to the sincipital end of the head would induce extension. And further, in making traction, a great deal of the force will be misapplied ; for while the head must travel downwards and backwards in the line of the axis of the brim (Fig. 317 *a*, *b*), the direction of traction exerted by the forceps is in a line (*e*, *x*, *f*) intermediate between this and the axis of the outlet (*c*, *d*). A great deal of force will therefore be lost, and the soft parts crushed which lie between the head and the pubes. The misdirection of force is represented by the 'angle of error,' *b*, *x*, *f*. The application of this instrument to the head *in the pelvic cavity* is also open to objection,

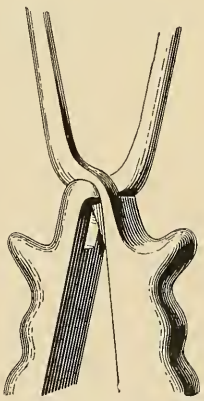


FIG. 319.—The Double Slot (English) Lock, and Shanks.

for it cannot be made to travel in any part of the pelvic axis without loss of much of the force applied.

The first observer who attempted to remedy the faults of

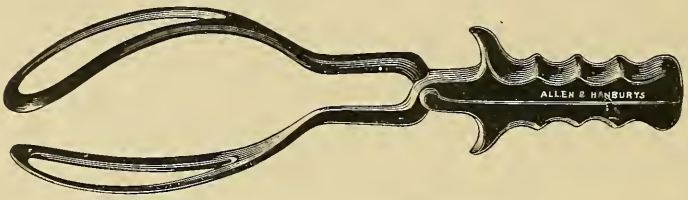


Fig. 320.—Long or Curved Obstetric Forceps.

the straight forceps was Levret, of Paris (1751), who curved the blades forwards, so that they would lie accurately in the curve of the pelvic canal (Fig. 320) : this second curve has become known as the *maternal* or *pelvic curve*. Minor

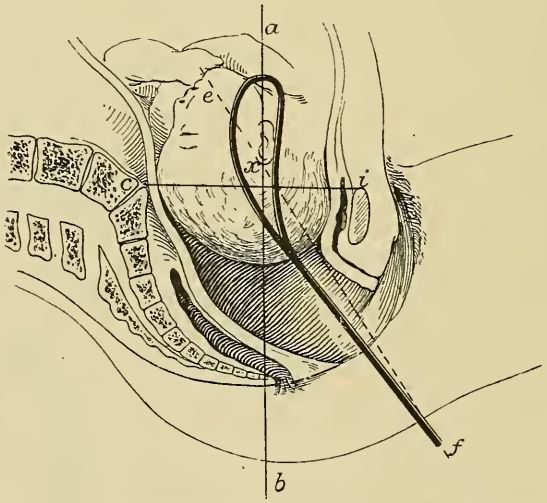


Fig. 321.—Long Forceps applied to the Head at the Brim.
(Milne Murray.)

a, *b*. Axis of pelvic brim. *e*, *i*. Plane of pelvic brim.
e, *x*, *f*. Direction of traction made by forceps.

modifications were made about the same period by a Scottish doctor practising in London named Smellie, who invented the double-slot lock, now used in all British forceps, and introduced between the blade and the lock a straight portion, $2\frac{1}{2}$ inches long, named the *shank*, which increased

the length of the instrument so that the operator could lock it outside the vulva when applied to the head at the brim (Fig. 319). The result of these alterations was thus to lengthen the forceps and add the pelvic curve. This instrument is now known as the *long* or *curved forceps*. As constructed at the present day it is made entirely of metal, so that it can be boiled. The total length of the instrument is 15 inches ; the cephalic curve of the blade has a radius of $4\frac{1}{2}$ inches, and allows a maximum separation in the centre of $3\frac{3}{8}$ inches, with a minimum separation at the points of 1 inch ; the pelvic curve has a radius of 7 inches.

The great advantage of the pelvic curve is that it enables the forceps to obtain a central grip of the head, which does

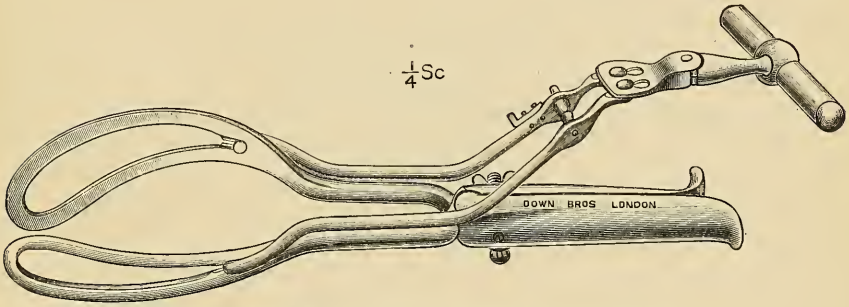


Fig. 322.—Milne Murray's Axis-traction Forceps.

not disturb its attitude ; but as in the case of the straight forceps there is great misdirection of the line of traction (compare Figs. 317 and 321). The direction of traction exerted by the instrument is represented by a line joining the handles with the centre of the fenestrum (Fig. 321 *e*, *x*, *f*). This line does not pass through the centre of the pelvis at all, but lies entirely in front of it when the instrument is applied to the head at the brim ; its direction also diverges widely from the axis of the brim. The misdirection of force is represented by the angle *b*, *x*, *f*.

The long forceps received a further important modification at the hands of Tarnier, of Paris, in 1877. This observer first introduced the principle of *axis traction*—*i.e.*, he modified the instrument so that at whatever level the head may lie, traction may be accurately applied to it in the *axis* of the

pelvis, thus enabling all the force exerted to be employed in the most advantageous manner. This he did by adapting to the ordinary long forceps used in France a pair of curved metal rods by which traction could be made, known as the *axis-traction rods*. There are a number of points of difference between the French and English obstetric forceps which need not be described, but Tarnier's invention was applied in 1880 to the English forceps by Sir Alexander Simpson.

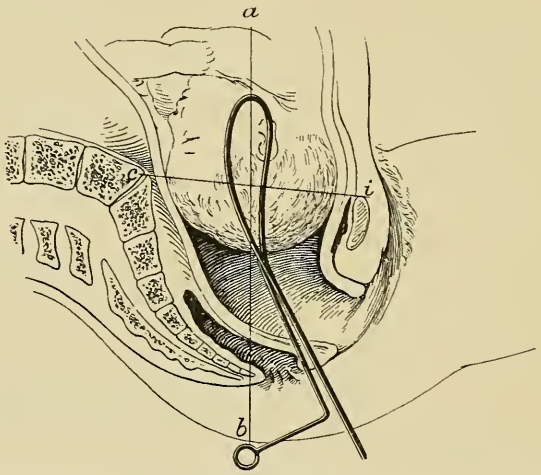


FIG. 323.—Axis-traction Forceps applied to the Head at the Brim. (Milne Murray.)

a, b. Axis of pelvic brim coinciding with line of traction.

Simpson's instrument was further modified and improved by Milne Murray.

The axis-traction forceps of Milne Murray is shown in Fig. 322. The traction rods are attached by a slot at the base of the fenestrum on each side ; they are curved so as to lie in accurate contact with the lower ends of the blades and the shanks ; opposite the lock they are curved away from the handles, and connected together at their ends with an easily worked attachment. The ends of the traction rods lie about $3\frac{1}{2}$ inches from the handles. To the ends when united is attached a transverse bar moving on a ball-and-socket joint, with which traction can be made. As the handles of the blades are only used in applying the instrument, and are not grasped when making traction, a screw is attached to them

by which the grip of the blades upon the head can be retained. This is known as the ' fixation screw ' ; it is not intended to produce compression of the head, but simply to retain the grip of the blades when traction is being made. The handles themselves are made much lighter than in the ordinary long forceps, and may be conveniently distinguished as the ' application ' handles, the transverse bar attached to the traction rods being called the ' traction ' handle. The

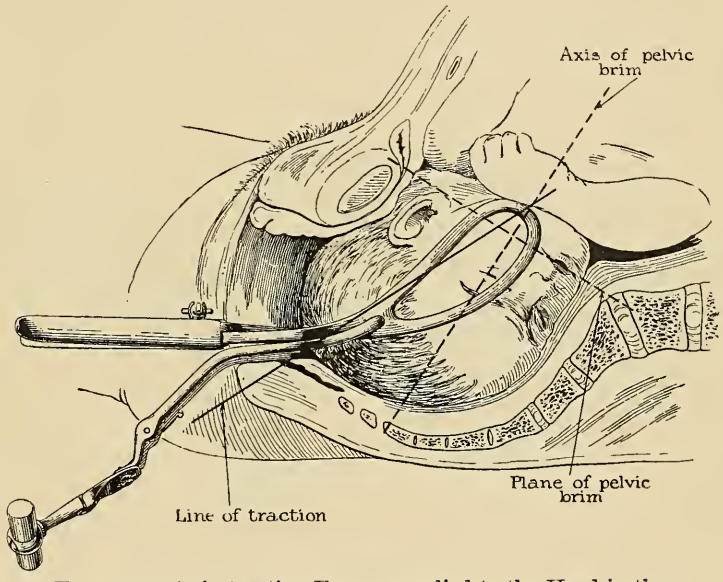


Fig. 324.—Axis-traction Forceps applied to the Head in the Pelvic Cavity. (Simpson.)

Note.—The line of traction is represented a little in front of its true position.

traction rods and handle are detachable, and the whole instrument can be sterilised by boiling.

When this forceps is applied to the head at the brim, traction made with the traction handle will cause the head to descend in the axis of the brim so long as the traction rods are kept in contact with the shanks (Fig. 324). The direction of the force applied is represented, in all positions of the instrument, by a straight line running from the point of application of the force (traction handle) through the centre of the fenestrum ; when the head is at the brim, this line coincides exactly with the axis of the brim (Fig. 323) ; when

the head is in the pelvic cavity, it coincides with the axis of the cavity at the level occupied by the head (Fig. 324)—*i.e.*, a line intermediate between the axis of the brim and the axis of the outlet. As long as the traction rods are kept in contact with the shanks, the line of traction will always correspond with the axis of that part of the pelvis in which the head lies; and in pulling the head through the pelvis the application handles will be observed to incline more and more to the front as the head descends (see Figs. 332 and 333).

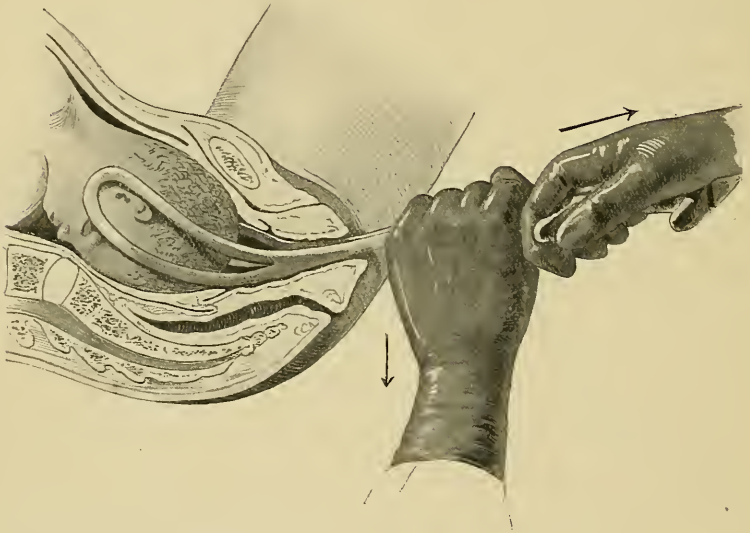


FIG. 325.—Pajot's Manœuvre.*

It follows that none of the force applied is wasted, for the angle of error (*b*, *x*, *f*) seen in the case of the short forceps and the ordinary long forceps has entirely disappeared (compare Figs. 317, 321, and 323).

Various attempts have been made to apply the principle of axis-traction in other ways. (1) It is maintained that axis-traction can be made with sufficient accuracy with the ordinary long forceps by the manœuvre of Pajot (Fig. 325). The right hand grasps the handles, making forward traction upon them; the left grasps the shanks above the lock and

* The use of rubber gloves for the forceps operation is optional.

makes backward traction upon that part of the instrument, forming a fulcrum between the two hands, upon which the blades will swing somewhat backwards when traction is being applied. It is clear that it will be impossible to obtain even approximate accuracy of direction in this manner. (2) The second method is that of Neville (Fig. 326). Neville's forceps differs from Milne Murray's in having but a single traction rod, which is attached to the forceps just below the lock by a butterfly joint. The traction bar is differently jointed, but, like Milne Murray's, will move in all directions. The advantage possessed by this instrument is that it is

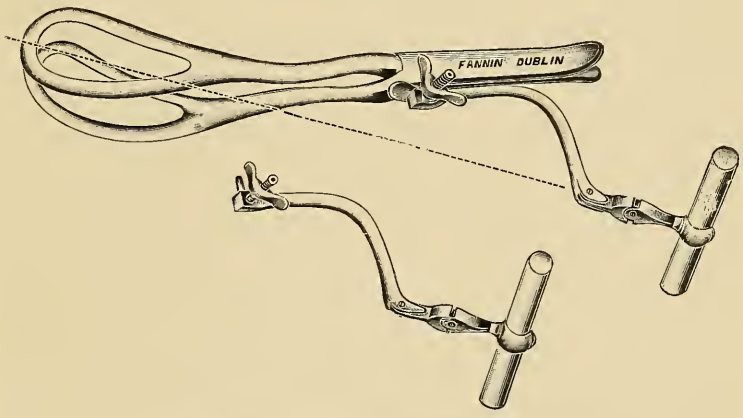


Fig. 326.—Neville's Axis-traction Forceps.

easier to apply than Milne Murray's, but the direction of traction is probably not so accurate.

It must be recollected that the axis-traction forceps is designed to work in a pelvis of normal shape : when the pelvis is contracted so as to distort its axis many of the advantages which the instrument possesses are lost. This objection, of course, does not apply to its use in the generally contracted pelvis.

Modes of Action of Obstetric Forceps.—The action of the obstetric forceps is essentially that of making *traction ;* the blades also compress the head, but the amount of *compression* should be only so much as is required to ensure a firm grasp. When properly applied the possible degree of compression is small, and is strictly limited by the cephalic

curve of the instrument. If the head is gripped transversely, the bi-parietal diameter cannot be reduced below $3\frac{3}{8}$ inches. It is probable that prolonged compression of the head even to this extent may cause a certain amount of injury to the brain, for in such cases the child is often born in a condition of white asphyxia. But injury to the cranial bones cannot be produced by this grip if the pelvis is normal. As we shall see, the usual grip obtained is transverse, or slightly oblique from before backwards.

It is when the instrument is so applied as to take an antero-posterior grip of the head that there is the greatest risk of injury. Reduction of size in this plane is followed by a compensatory increase in the vertical diameter—*i.e.*, the distance between the vertex and the base is increased. The transverse (bi-parietal) diameter is not much affected.

In occipito-posterior positions the forceps is sometimes used forcibly to *rotate* the head so as to bring the occiput forwards. This cannot be done, however, without risk of injury to the soft parts.

A *lateral lever action* may be exerted during traction by carrying the handles gently from side to side ; this sometimes aids extraction in a difficult case.

It is also clear that, when the head is in the grasp of the forceps, the lower parts of the blades will exercise a *dilating action* upon the vulva immediately in advance of the head (Fig. 333). And lastly, the mere introduction of the blades often exerts a powerful *excitant action* upon the uterine contractions.

The variety of obstetric forceps which will be found most generally useful is the axis-traction forceps ; and Milne Murray's pattern is to be preferred on account of its greater accuracy. To operators who have become accustomed to the ordinary long forceps, the axis-traction forceps appears clumsy and its application difficult ; but students can learn to apply it quite as easily as the long forceps. It is a great advantage to carry one kind of forceps only, and this is the only kind which is sufficient for all the requirements, whether of an easy or a difficult case. It is advantageous also to use the same form of instrument in all forceps operations, so as to become thoroughly familiar with its use ; and while it may be admitted that a *low* forceps operation can be easily

performed with the ordinary long instrument, this certainly is not the case with a *high* operation ; here the axis-traction instrument is far more effective. The same must be said of pelvic contraction and all other conditions in which a considerable amount of force is required in traction ; the axis-traction pattern is far more effective. Since all the force applied through the instrument is effective, and none is lost, obviously the amount of force required is reduced to the minimum. When the head is low in the pelvic cavity the blades can be used without the traction rods, like an ordinary pair of long forceps.

It must also be borne in mind that this forceps does not interfere with the normal movement of rotation made by the head in passing through the pelvis, for the ball-and-socket joint on the traction handle allows the instrument and the head to rotate together. With the ordinary forceps, owing to the firm grip of the handles which is required, spontaneous rotation cannot occur, although of course forcible rotation can be performed by the operator.

It has been urged that excessive and continuous compression of the head is caused by the screwing together of the handles of the axis-traction forceps ; this is not the case, for, as we shall see, continuous compression implies improper use of the instrument ; the degree of compression required is only that necessary to ensure a firm grip of the head, and this can be regulated with far more accuracy by the screw than when the handles are firmly gripped in the act of making traction. The only valid objection to the instrument is its greater complexity, and the corresponding greater difficulty in manipulating it ; this can be readily overcome by practice.

Indications for the Use of Forceps.—The obstetric forceps is an instrument designed for application to the head in presentations of the vertex, brow, or face, and to the after-coming head in breech labours. It is also by some authorities applied directly to the breech in breech presentations, but the instrument is not adapted for this purpose ; other methods of delivering a difficult breech presentation can always be employed with success.

When the head has passed through the brim, and lies with its greatest circumference in the pelvic cavity, the

operation is simple and easy; the lower the head has descended before the forceps is applied, the easier will be the extraction. This is often spoken of as the *low forceps operation*. When the head lies entirely above the pelvic brim, freely movable, unengaged and unmoulded, the operation is very difficult to perform and involves considerable danger to the child. If the pelvis is contracted or the head abnormally large these difficulties and risks are considerably increased. This operation, which is often spoken of as the *high forceps operation*, is accordingly not to be recommended unless other methods of delivery *per vias naturales*, such as internal version, are impracticable. While the operation cannot be actually condemned, it should never be undertaken lightly, or without first giving due consideration to other possible methods of delivery.

It will be clear that cases may be met with intermediate between these two classes—*i.e.*, cases in which, although the head is engaged in the brim and partly moulded, the greatest circumference has yet failed to pass through the pelvic inlet. In such cases resort to forceps should be delayed as long as may be possible, due watch being kept upon the condition of the fœtal heart, and the general condition of the mother. If the pelvis is of normal size the operation may be undertaken earlier and with better prospects of success than when the pelvis is contracted. The importance of allowing full time for moulding, in the latter condition, has been already insisted upon.

The actual *indications* for the use of forceps in head presentations may be arranged into three groups:

(1) Abnormal prolongation of the second stage.
(2) Maternal complications.
(3) Fœtal dangers, indicated by signs of distress or prolapse of the cord.

In breech presentations, if the after-coming head cannot be promptly delivered by the digital methods described on p. 369, the forceps should be at once applied.

(1) *Prolongation of the second stage.*—Forceps should not be applied merely to save the time of the medical attendant, or to shorten the duration of the second stage when labour is proceeding naturally. The length of the second stage is variable, and for practical purposes the strength of the pains

must be taken into consideration, as well as the actual time which has elapsed. When the pains are feeble and irregular, much more time must be allowed than when they are strong and regular. When the head is detained in the upper part of the pelvis the use of forceps should be withheld as long as possible. When it has reached the pelvic floor and presents at the vulva there is not the same reason for delay.

These points being borne in mind, the following conditions may be enumerated as causes of abnormal prolongation of the second stage :

(*a*) Uterine inertia—primary or secondary.
(*b*) Occipito-posterior positions.
(*c*) Rigidity of the perineum.
(*d*) Pelvic contraction.
(*e*) Abnormally large size of the head.
(*f*) Abnormal uterine obliquity.
(*g*) Mento-posterior positions of the face.

In every case an attempt should be made, before applying forceps, to arrive at a conclusion as to the cause of the delay. It will be found that the three first-named conditions account for something like 90 per cent. of the cases in which the forceps is used. When the head is delayed on the pelvic floor the usual cause is to be found in ineffective contractions, or an unyielding perineum ; in rare instances contraction of the pelvic outlet may be present as in a funnel pelvis. When the head is detained in the upper part of the pelvic cavity, and the uterus is contracting well, the commonest causes are a posterior position, or some disproportion between the size of the head and that of the pelvis. In the latter an abnormally large caput will form, and the head will become fixed ; in the former the caput is not abnormally large and the head usually remains movable. Therefore, when the delayed head shows a large caput, attention must always be directed to the size of the pelvis.

(2) *Maternal complications.*—In such conditions as heart disease it is obvious that prolongation of the muscular strain which accompanies the second stage must be detrimental to the mother, and accordingly forceps should be employed early in this stage. In eclampsia all obstetricians agree that as soon as the cervix is sufficiently dilated extraction with

forceps is indicated ; as in the majority of cases labour is premature and the fœtus small, extraction is not often difficult, even in a primipara. Sometimes in cases of premature rupture of the membranes signs of obstetric exhaustion may appear before dilatation has been completed, and to these may be added signs of fœtal distress. Under such circumstances prompt delivery by forceps must be practised, the dilatation having been previously completed by the digital method, or with the additional aid of incisions in the cervix.

(3) *Fœtal complications.*—The early use of forceps may be indicated by signs that the fœtus is suffering from the effects of labour, such as passage of meconium, or slowing of the rate of the heart sounds. This is especially likely to occur with a premature fœtus or with premature rupture of the membranes. Prolapse of the cord may also call for the early use of forceps. When the fœtus is dead, forceps delivery is suitable as long as the pelvis is of normal size and the head is not abnormally large. But in such cases, should extraction prove to be difficult, the forceps should be at once abandoned in favour of craniotomy.

Forceps in Pelvic Contraction.—It has been already mentioned in connection with the management of labour in pelvic contraction (p. 416) that unless the conjugate measures at least $3\frac{1}{2}$ inches, a full-time child of average size cannot be extracted by forceps without great risk of seriously injuring it. Consequently it is better not to undertake forceps delivery in a pelvis smaller than $3\frac{1}{2}$ inches. If a case is first seen at an advanced period of labour, when the head is firmly engaged in the brim, accurate measurement of the pelvis is impossible. We must then be guided by the amount of compression of the head which has taken place, as indicated by overlapping of bones and by the size of the caput. It has been already explained that an unmoulded head is much more difficult to deliver than one in which moulding has definitely occurred ; but if the greater part of the head, though moulded, remains above the pelvic brim, the prospects of delivery by forceps are unfavourable.

In all cases of pelvic contraction attempts to deliver with forceps must be made carefully, and should not be persisted in if no progress is being made after two or three steady pulls.

The shape of the pelvis is not of much importance from the point of view of the forceps operation ; in both flat and generally contracted pelves it may be used with equal success in suitable cases. After failure to deliver with forceps it is, as a rule, unwise to attempt version ; if the head is firmly engaged in the brim and there is little liquor amnii present, version should never be performed, owing to the risk of rupturing the uterus ; if, however, these conditions are not

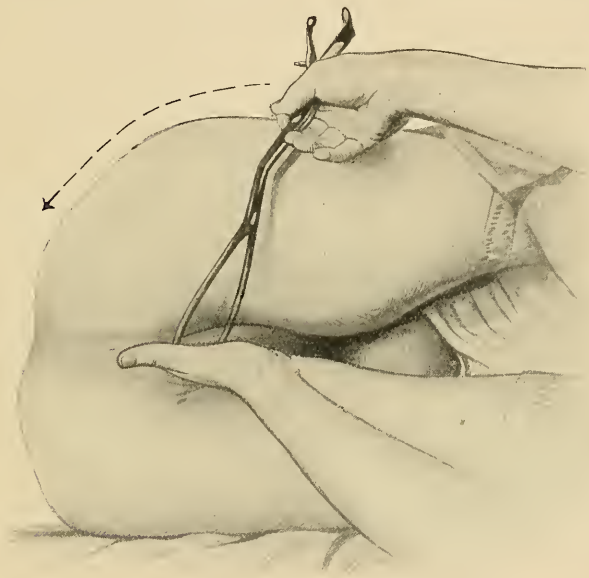


Fig. 327.—Application of Axis-traction Forceps. Introducing the left blade.

present, version may be performed if the pelvis is flat, but never if it is generally contracted. In all varieties of contracted pelvis, axis-traction forceps are much more successful than the ordinary long forceps.

Application and Use of Forceps.—*Preliminaries.*—Careful antiseptic preparation of the hands of the operator and the vulva of the patient is of course necessary. In some schools of midwifery the use of sterilised rubber gloves by the operator is advised in all cases. In the opinion of the author this precaution is not necessary in the *low operation,*

but should be used in the *high operation*, as it is never desirable to introduce the entire uncovered hand into the vagina. Shaving and disinfecting the vulva is a much more valuable preventive of infection than the use of gloves by the operator, and in the author's opinion, it should be practised whenever the patient is anæsthetised for any obstetric operation. If sterilised gloves become soiled in passing through the vulva the chief advantage of using them is

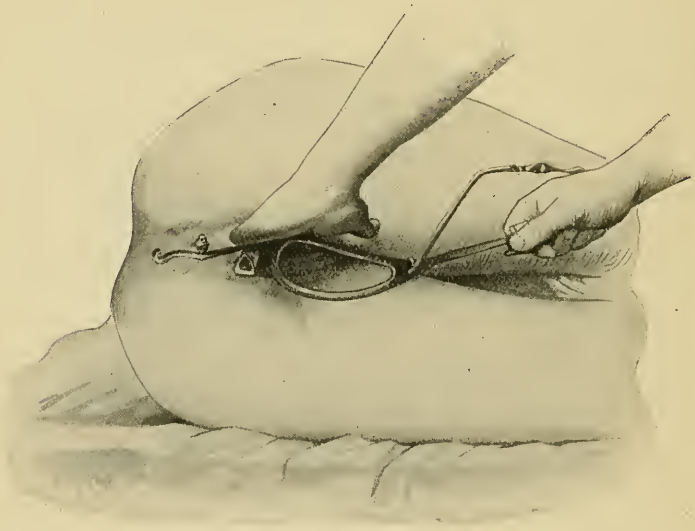


FIG. 328.—Application of Axis-traction Forceps. The left blade is in position, the handle only being seen; the right blade is being introduced.

lost. The previously boiled forceps should be immersed in a large ewer of lysol solution (5j. to Oj.) or carbolic (1 in 40) until required for application. The bladder must always be emptied by catheter, and an anæsthetic is desirable in all cases. The left lateral posture, the patient lying across the bed, is usually employed in this country, but the dorsal posture, with the legs flexed and the buttocks drawn to the edge of the bed (Fig. 337), is of great assistance in cases of difficulty, and the operator should become familiar with it; the former has the advantage of requiring fewer assistants.

When the lateral posture is used the buttocks are drawn over the edge of the bed, and the right leg must be supported throughout the operation by an assistant in the position shown in Fig. 327. A detailed examination of the presenting head should first be made, and for this purpose it is necessary to pass the 'half hand' into the vagina. This will enable the operator in cases of difficulty to locate the ears, which are useful in the diagnosis of position when the sutures and fontanelles are obscured by a large caput. The curve of the helix always corresponds with the occipital end of the head. Posterior positions should, if possible, be corrected by manual rotation. If the cervix is incompletely dilated, the requisite degree of dilatation should be secured by the digital method, aided in some cases by lateral incisions. If the membranes remain unbroken they should of course be ruptured artificially.

Application of the Axis-traction Forceps.—(*a*) *When the head is in the lower part of the pelvic cavity.*—In a simple case the blades are applied in the transverse diameter of the pelvic cavity. As a rule the movement of internal rotation is incomplete, and consequently the blades grip the head in its oblique diameter—*i.e.*, intermediate between the transverse and the antero-posterior. If internal rotation is complete the head will be gripped in its biparietal diameter.

The left half is usually applied first ; this will be the lower half in the left lateral posture. The handle is held lightly in the right hand, the traction rod being kept in close contact with the shank. The fingers of the left hand are passed into the vulva and carried up into contact with the cervix on the left side of the head. The blade is then passed along the palmar surface of the fingers in the antero-posterior diameter of the vulva, and directed at first backwards towards the sacral hollow, the instrument being held in a nearly vertical position as shown in Fig. 327. The handle is then carried backwards in a wide sweep, and the blade at the same time directed by the internal fingers to the left (of the mother) until it lies in the transverse pelvic diameter ; the blade must be kept in contact with the scalp, the lip of the external os being protected by the fingers. This movement sweeps the blade round the left (maternal) side of the head. Without

exerting any force, the blade will be found to pass deeply the pelvis until the shank comes to lie upon the perineum (Fig. 327). The traction rod now lies behind the applied blade. The left blade may be held in position by an assistant as shown in Fig. 329 ; unless held in this way while the other blade is being introduced it will not remain in the position in which it has been placed. The right half of the forceps is

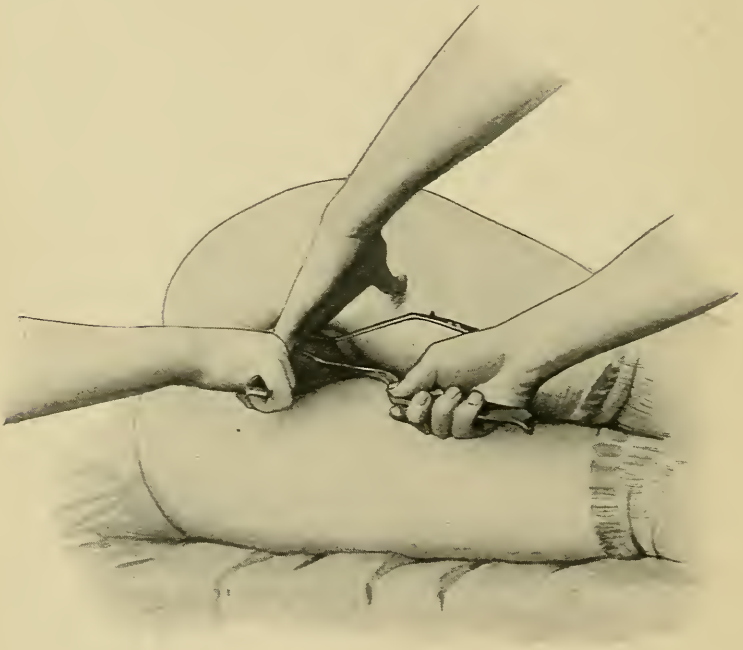


Fig. 329.—Application of Axis-traction Forceps. Further stage in introduction of the right blade.

next taken in the right hand, the left hand is pronated, and the fingers used as before to guide it into the vulva. The blade is first directed towards the sacral hollow, and then, the handle being held parallel to the left thigh, the blade is directed by the fingers round the right side of the pelvis into the transverse diameter, the same precautions being taken as in introducing the left half. It is necessary to *depress* the handle of the right half in order to carry the blade upwards to the right side of the pelvis (Fig. 329). The move-

ment is completed by carrying the handle backwards, as the blade passes deeply into the pelvis. Both traction rods should now lie behind the shanks, and the instrument is locked by taking a handle in each hand and carefully adjusting the slots (Fig. 330). It is convenient to have the traction rods held back by the fingers of an assistant when locking the forceps ; but this is not required after a little practice. If the instrument has been accurately applied the shanks will lie in such a position that locking is easy ; sometimes however the blades lie so that they cannot be locked

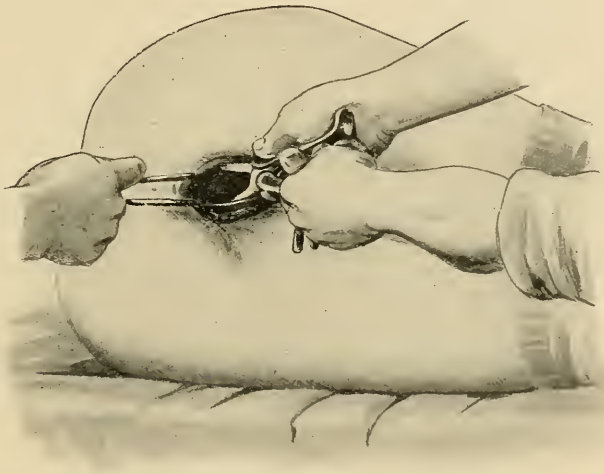


Fig. 330.—Application of Axis-traction Forceps. Locking the blades; the traction rods are held aside by an assistant.

without forcibly rotating one or both of them, in order to adjust the slots to one another. If the blades have been carefully applied in the transverse diameter of the pelvis, difficulty in locking signifies that rotation of the head has not occurred, and the blades should be removed and reapplied in an oblique diameter of the pelvis (*vide infra*). Serious injury to the head may result from forcibly locking badly adjusted blades. After locking, the application handles are screwed lightly together with the fixation screw. They lie against the perineum, and it will be noticed that they are directed downwards in the axis of the pelvic cavity

(Fig. 331). Next the traction rods are connected, and the traction handle applied. A careful examination should be made before traction is begun, to make sure that nothing but the head has been included in the grip of the instrument.

Difficulty in the application and adjustment of the blades, if not due to inexperience, usually results from a faulty position of the head. In occipito-posterior positions, when rotation has not occurred either forwards or backwards,

Fig. 331.—Showing the Position of the Traction Rods and Handles after the instrument has been applied.

there is often great difficulty in obtaining a satisfactory grip of the head when the blades have been applied, as described, in the transverse diameter of the pelvis. It has already been explained that such cases should, if possible, be treated by manual rotation before forceps is applied (see p. 340). When the head lies in an oblique diameter with the occiput forwards the difficulty can be overcome by applying the blades not in the transverse diameter, but in one of the oblique diameters of the pelvis. Thus in a first position the left blade would be directed towards the left sacro-iliac syn-

chondrosis, the right towards the right pectineal eminence, so that the instrument would lie in the left oblique diameter, and would thus obtain a grip of the head in its biparietal diameter. In a second position the blades would lie in the right oblique diameter, the left blade being carried a little in front of the transverse, the right a little behind it. While traction is being made rotation will occur, as the head comes down, either in a forward or backward direction, according to the conditions previously discussed (p. 299).

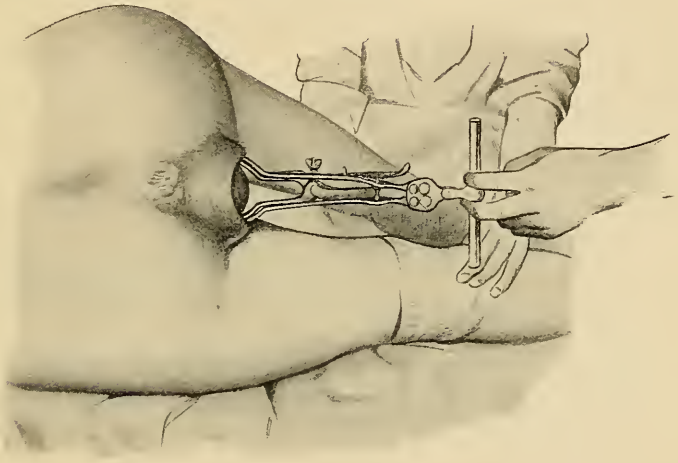


Fig. 332.—Delivery by Axis-traction forceps. Traction in the direction of the axis of the pelvic cavity.

Before delivering the head the blades should then be taken off and reapplied in the transverse diameter.

Extraction of the Head.—Three points must be continually borne in mind in extracting the head with the axis-traction forceps : (1) to keep the traction rods always in contact with the shanks ; (2) to pull only during uterine contractions and to pause during the intervals ; (3) to ease the fixation screw whenever traction is not being made. In the low operation the direction of traction will be at first downwards, but as the head descends the application handles will of themselves move forwards, and the traction rods must be made to follow them (Figs. 332 and 333) ; if this point is carefully attended to traction will always be

made exactly in the pelvic axis. Little or no time will be lost in pausing during the periods of relaxation of the uterus, unless the patient is deeply anæsthetised, for the presence of the instrument in the genital canal powerfully excites uterine contractions. The object of easing the screw of the application handles is of course to avoid the risk of prolonged and continuous compression of the head. When the head and the pelvis are of normal size, the amount of force required with this instrument is small, and delivery can often be effected by making traction with two fingers only. If during

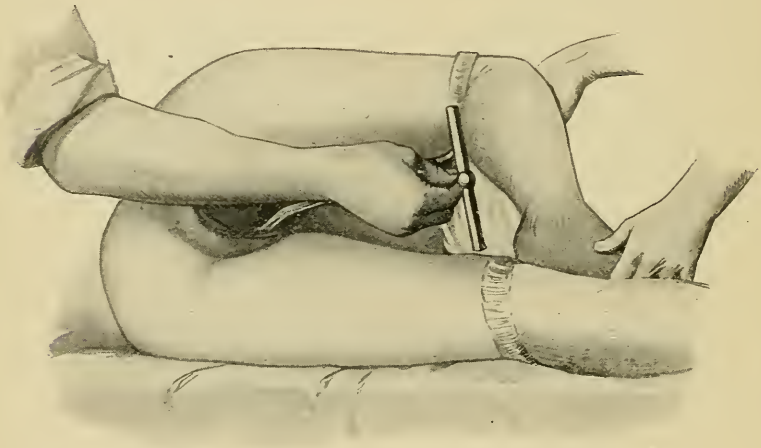


Fig. 333.—Delivery by Axis-traction Forceps. Traction in the direction of the axis of the pelvic outlet.

traction the instrument should be felt to slip, it must be taken off and re-applied. When marked rotation of the head occurs during its descent, so as to bring the blades nearly or quite into the antero-posterior diameter, the instrument should be removed and re-applied, or serious laceration of the vulva may be caused by the edges of the blades. When using the lateral position in the final stage of extraction, the line of traction required is across the body of the patient, and the handles will come into a line almost parallel with the anterior surface of the pubes (Fig. 333). The instrument may now be gripped by the shanks with the right hand, until the head is fixed in the outlet, when the forceps may

be removed and the head delivered by expression. In removing the instrument the traction handle is first taken off, then the fixation screw loosened and the traction rods disconnected from one another; the blades can then be separately withdrawn.

(*b*) *When the head is in the upper part of the pelvic cavity.*— In these cases a careful estimate must be made of the size of the pelvis, and the relative size of the fœtal head. In the absence of uterine inertia, some degree of obstruction is

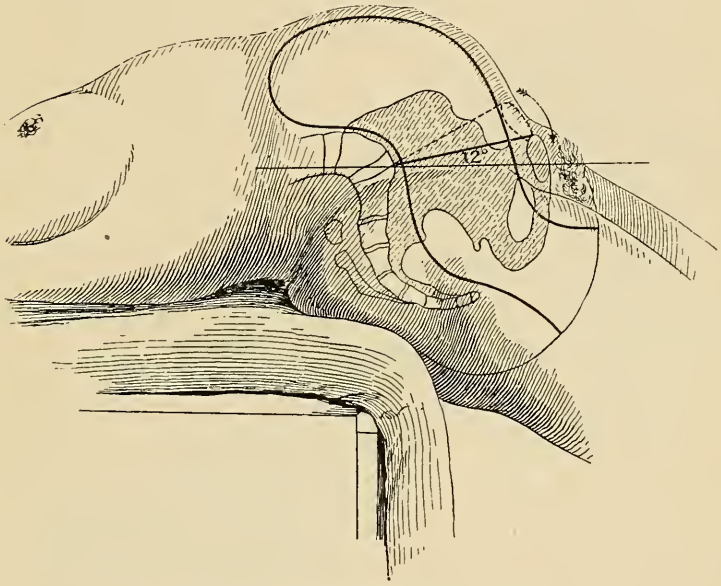


Fig. 334.—Walcher's Position. (Edgar.)

the commonest cause of arrest of the head in this part of the pelvis. The presence of an unusually large caput, and of extreme cranial moulding, would also suggest that some degree of obstruction is present. Before applying forceps it is therefore desirable to endeavour to estimate the amount of pelvic space which is available. It is very difficult to measure the diagonal conjugate during labour when the head is firmly engaged in, or has passed, the brim. A careful bi-manual examination of the head, after the method of Müller (p. 421) should be made, so as to observe the size of that portion which still lies above the brim. If the greatest

cranial circumference has not passed through, great difficulty in delivery with forceps may be experienced. If the pelvis is normal and the head of not more than average size, arrest in the upper part of the pelvis is usually the result of insufficiency of the pains. It is sometimes difficult in high cases to obtain a firm grip of the head, the forceps slipping as soon as traction is begun. This accident will usually be

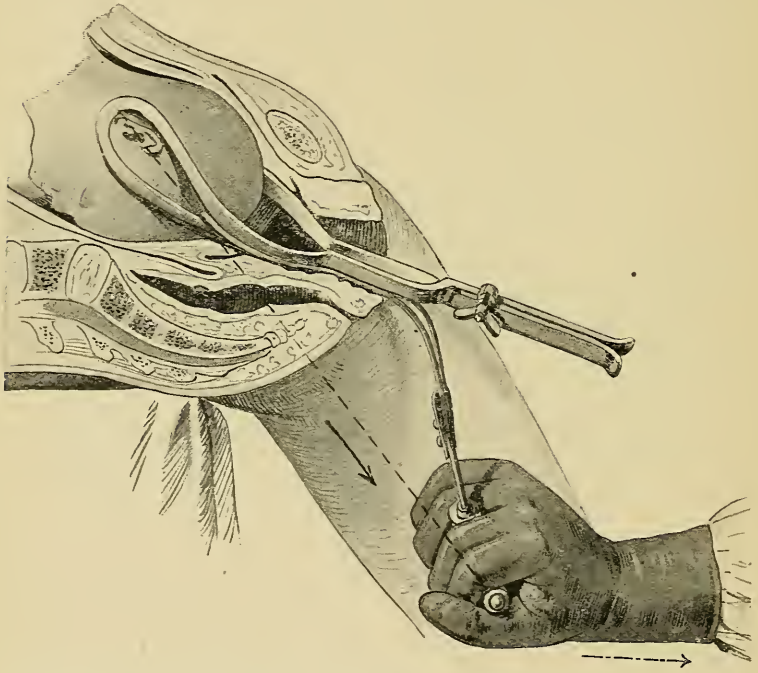


FIG. 335.—The Axis-traction Forceps in Walcher's Position, showing the direction in which traction is made.

found to be due to non-rotation of an occipito-posterior position.

(*c*) *When the pelvis is contracted.*—If the pelvis is *flat* the head nearly always engages in the transverse diameter; consequently in applying the forceps in that diameter, an occipito-frontal grip of the head will be obtained. This grip is certainly more likely to cause cranial injuries, but does not increase the difficulty of delivery, since the com-

pensatory increase occurs not in the bi-parietal diameter, but in a vertical diameter of the head. It is of no use to attempt to grip the head in any other diameter in such cases.

Having applied the blades, one or two tentative pulls should be made to make sure that the grip of the instrument is secure. The patient should then be placed in Walcher's position for the extraction of the head (Fig. 335). In this position the patient is placed upon her back, with the buttocks over the edge of the couch and slightly elevated on firm pillows. The couch or bed must be high enough to allow the lower limbs to hang over the end without touching the floor. The effect of the hanging position of the legs is to alter the angle of the plane of the brim so as to reduce its inclination to the horizontal, and also slightly to lengthen the conjugate diameter of the brim. This position will therefore allow of the easier delivery through the brim of a tightly fitting head. In pulling the head through the brim the line in which it must move will be nearly vertical, for the axis of the brim in its altered inclination is more nearly vertical than in the usual position. The operator sits upon the floor between the patient's thighs (Fig. 335). When the head has passed through the brim, the legs should be flexed and supported by assistants, while the operator changes the line of traction, directing it rather sharply forwards as the head reaches the outlet. If internal rotation now occurs, the forceps should be taken off and re-applied to avoid delivering the head in an oblique diameter.

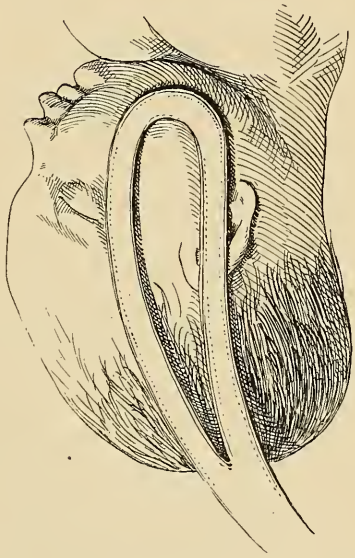


FIG. 336.—Showing the favourable Grip of the Forceps in an Occipito-anterior Position.

In the *generally contracted pelvis* Walcher's position is

not of the same advantage, since the whole pelvis is small, whereas in the flat variety the difficulty is solely or mainly at the brim. The difficulty of forceps delivery is accordingly greater in a generally contracted pelvis, and there is more risk of injury to the child.

In the *funnel pelvis* great difficulty may be met with in delivering the head through the outlet. Whitridge Williams has shown that Sims' position and the elevated lithotomy position are both of great service here as they produce an appreciable enlargement of the antero-posterior diameter of the outlet. In the elevated lithotomy position the patient is supported with a Clover's crutch, and the buttocks are further raised above the level of the table on a firm pillow before the forceps is applied. The Sims' position is described on p. 322.

Application and Use of Ordinary Long Forceps.—The application of the blades is carried out in precisely the same manner as the axis-traction forceps up to the locking of the handles ; traction can then be at once commenced. The same precautions in delivering should be observed ; the firm grip of the handles, which is necessarily used when making traction, probably exerts more injurious pressure upon the head than does the fixation screw of the axis-traction instrument ; during the intervals the handles should accordingly be slightly separated without actually unlocking them, so as to diminish the pressure upon the head. Great care must be exercised throughout in directing traction as far as possible in the pelvic axis ; the difficulties of effecting this have been already referred to.

The blades of axis-traction forceps, without the traction rods, may be used as a substitute for the ordinary long forceps. When the indication for speed is urgent, as in forceps extraction of the after-coming head, this instrument is preferable, as it can be applied more rapidly.

Application of Forceps in the Dorsal Position.—In cases of difficulty, such as an unreduced occipito-posterior position, or a contracted pelvis, the dorsal position will often be found to allow of easier delivery with forceps than the lateral position. It is therefore desirable to become practised in the use of the instrument in this position. The operator stands between the flexed and abducted thighs, which are

held by assistants. The left half should be passed first as shown in Fig. 337 ; the blade is directed first of all back-

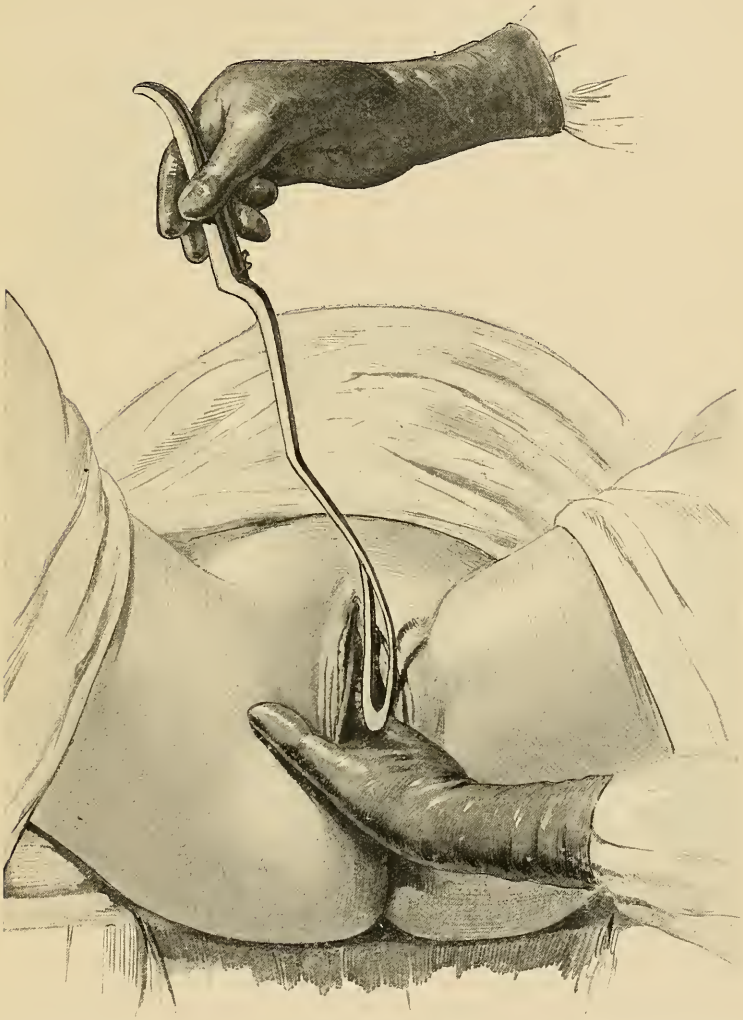


Fig. 337.—Application of Ordinary Long Forceps in the Dorsal Position. Introducing the left blade.

The instrument used in Figs. 337 and 338 is an axis-traction forceps without the traction rods.

wards into the sacral hollow, and then into the transverse diameter, the handle being swept over to the right (of the

mother) and then backwards on to the perineum. In introducing the right half, the blade is passed *over* the left (Fig. 338), and then directed into the transverse diameter,

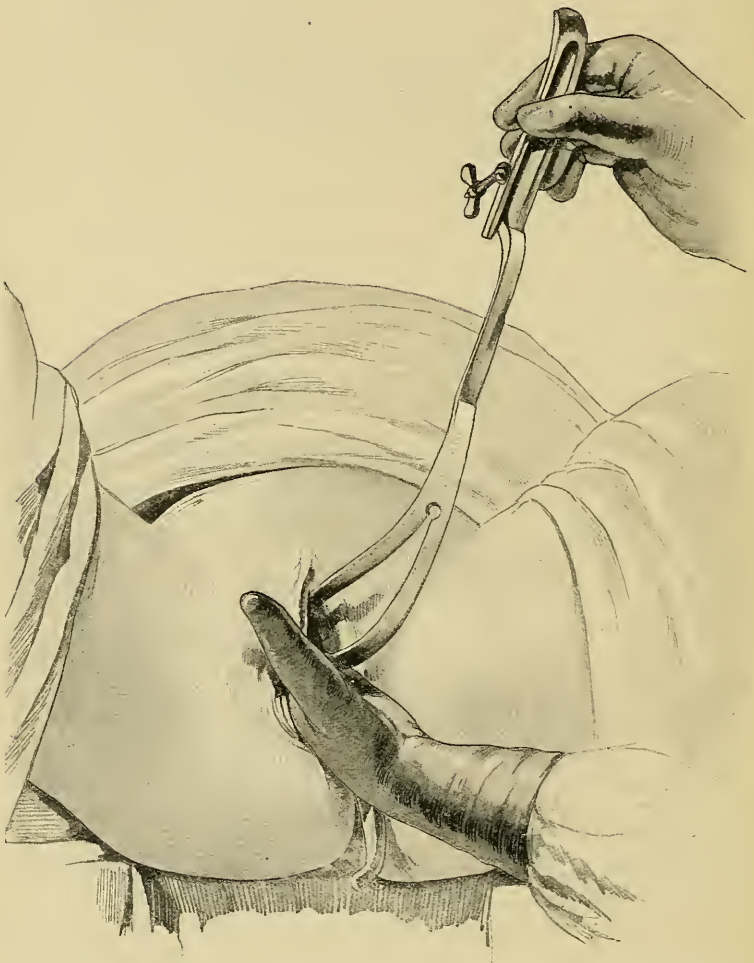


Fig. 338.—Application of Ordinary Long Forceps in the Dorsal Position. Introducing the right blade.

the handle being swept over to the left (of the mother) and then backwards to meet the handle of the left half which has been already introduced. In the figures the instrument used is the axis-traction forceps without the traction rods.

The presence of the latter undoubtedly renders the application of forceps in this position somewhat difficult, but the difficulty can be readily overcome by keeping the traction rods always below (*i.e.*, behind) the handles. In extracting the head through the outlet in this position it must be remembered that the direction of traction will be upwards and forwards, *i.e.*, towards the operator.

Forceps in Face Cases.—In applying the instrument in

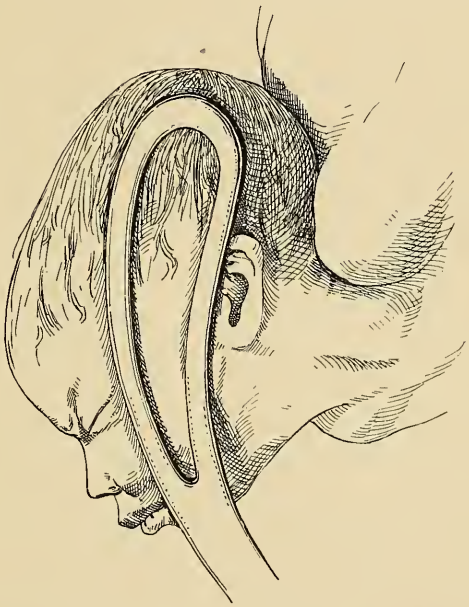


Fig. 339.—The Grip of the Forceps in Mento-anterior Positions of the Face.

these cases great care must be taken to avoid injuring the eyes. The blades are applied precisely in the same manner as in a vertex case, the grip of the head which will be obtained in mento-anterior positions being shown in Fig. 339.

Application of Forceps to the After-coming Head.—This operation may be performed when the head is retained in the *pelvic cavity* and digital methods of extraction have failed ; it is quite unsuitable when the head has not passed through the brim. If the occiput is anterior, the body of the child is held forwards against the mother's abdomen, and the forceps

applied in the usual manner behind it. Extraction will be easy unless the head is extended. When the occiput is posterior, the forceps must be applied in front of the child's body.

Risks of the Forceps Operation.—When strict antiseptic precautions are taken, when proper dilatation of the cervix has been previously secured, when the conditions are favourable as regards the relative sizes of the pelvis and the fœtal head, and when extraction is practised with care and skill, the forceps operation is devoid of any serious risk *to the mother*. In lying-in hospitals it is observed that the puerperal morbidity rate is definitely higher in forceps cases than in natural births. But this increase may well be due rather to the prolonged and difficult character of the labour in such cases than to the actual forceps operation. Serious lacerations of the cervix and vaginal vault, or of the vulva, may however be caused by inattention to the directions laid down for the use of the instrument ; lacerations in the former position are usually caused by performing the operation too early in labour ; in the latter position they may be caused by slipping of the blades, or by extraction after marked rotation of the instrument has occurred, or in delivering an unrotated occipito-posterior position. Attempts to deliver by forceps when there is insufficient pelvic space may cause serious lacerations, or from extreme or prolonged compression sloughing of some part of the vaginal wall may subsequently occur. Extraction performed too rapidly, or in the absence of uterine contractions, may lead to serious postpartum hæmorrhage. *To the fœtus* there is much more risk than to the mother : the *fœtal mortality* of forceps operations during recent years at Queen Charlotte's Hospital was 79 deaths in 1,300 cases, a mortality of 6 per cent. as compared with a general fœtal mortality for all cases of 2·25 per cent. It must however be recollected that in many instances the death of the fœtus may have been due to the long and difficult character of the labour, rather than to any actual injury inflicted by the forceps. A reference to the list of indications for forceps will make this clear. In fatal cases are frequently found such injuries to the head as fracture of the cranial bones with intra-cranial hæmorrhage, conditions which may lead to cerebral compression and asphyxia.

Minor injuries, such as compression of the facial nerve (Bell's paralysis) and effusions of blood under the pericranium (cephalhæmatoma), may also be caused by forceps.

Cæsarean Section

This operation consists in the removal of the fœtus from the uterus by abdominal incision.

Historical.—Although Cæsarean section was practised upon the dead mother in very early times, and was indeed so prescribed by Roman law, it was not until the Middle Ages that the first operation was performed during life. The first recorded instance occurred about the year 1500, when a Swiss pig-gelder performed it upon his own wife. The first serious treatise upon the subject was published in 1581 by Rousset. From the sixteenth to the middle of the nineteenth centuries the mortality attending it was so high as almost to prohibit the operation ; Lepage states that not a single case operated upon in Paris between 1799 and 1877 recovered. The general mortality even in the first half of the nineteenth century is known to have been over 50 per cent. There is no wonder that craniotomy and symphysiotomy were at this time strongly advocated as alternative procedures. One of the chief causes of the high mortality was that the uterine incision was not sutured, as at that time surgeons believed that ligatures could not be buried in the abdominal cavity owing to the risk of their suppurating ; the immediate causes of death were, no doubt, hæmorrhage and septicæmia. The first attempts to suture the uterus were made in 1835, but it was not until the introduction of Sänger's method, in 1882, that any satisfactory way of accomplishing it was devised. To this observer belongs most of the credit for the success which now attends the operation. Sänger's plan was to employ two series of sutures—one deep, the other superficial ; and no important modification of this method has been since introduced. The elaboration of antiseptic and aseptic technique during the last quarter of a century stands next in importance to suture of the uterine wound as a cause of the low mortality of the operation at the present time, which, in the hands of skilled operators and under favourable con-

ditions, does not exceed 3 per cent., while the fœtal mortality is about 5 to 6 per cent.

An important modification of the operation of Cæsarean section was introduced by Porro in 1876, six years previous to the publication of Sänger's method of uterine suture. Porro's operation consisted of amputating the body of the uterus after the extraction of the child, controlling the stump with a serre-nœud, and fixing it in the lower angle of the abdominal wound. It was introduced as a means of preventing hæmorrhage and sepsis, and was not a momentary inspiration, but the outcome of much consideration and experiment upon animals. He advocated its general adoption in the place of Cæsarean section. The expectations raised by the new operation were not generally realised, for in 1882 Godson collected 152 cases with a mortality of 56·57 per cent. To Porro, however, belongs the great credit of having been the first to conceive the idea of removing the uterus after extracting the child. Porro's operation has now been almost entirely abandoned, but the principle of the removal of the uterus in certain cases has become well established, the method adopted being usually the modern one of intra-peritoneal hysterectomy.

Two Cæsarean operations, distinct from one another in principle, have therefore to be considered: *Conservative* or *Classical Cæsarean Section*, in which the uterus, after being opened, is sewed up and returned; and *Cæsarean Hysterectomy*, in which the uterus is removed after the extraction of the child. Within recent years two modifications of Conservative Cæsarean Section have been introduced; their place in obstetric surgery is however, at present, undefined, and therefore they need be only briefly referred to.

A method of extracting a full-time child *per vaginam* by means of one or more deep incisions into the cervix was advocated by Dührssen in 1895, and named by him *Vaginal Cæsarean Section*. As has been already mentioned, this consists in the application to obstetrics of a well-known gynæcological procedure. This operation and the conditions under which it may be performed have been already described (p. 608). Still more recently a different modification of Conservative Cæsarean Section has been introduced,

designed to render the operation extra-peritoneal by exposing and opening the anterior uterine wall below the level of the firm attachment of peritoneum. This operation, known as *Extra-peritoneal Cæsarean Section*, is specially intended for application to cases in which the uterus has been infected, or is likely to have been infected, by previous unsuccessful attempts to deliver *per vias naturales*. It is supposed that by this method the risk of infecting the general peritoneal cavity when opening the uterus may be avoided. This point will be again referred to in considering Cæsarean section of an infected uterus.

Indications.—Owing to the present low mortality of Cæsarean section, the indications for its performance have been considerably extended in recent years. It is now performed under most of the conditions which were previously held to necessitate craniotomy upon the living child, and it will probably in time almost entirely replace symphysiotomy; while owing to the uncertainty of the survival of the child after induction of premature labour, it is encroaching, as has been stated in another place, upon the field of this operation also. As regards the maternal risk, it compares unfavourably with induction of premature labour, in which there is practically none; but the chances of the survival of the child in the second degree of pelvic contraction are very much greater by Cæsarean section than by induction. It must, however, be understood that this operation is only justifiable for moderate degrees of pelvic contraction, when it can be performed with adequate preparation and under favourable surgical conditions. In the case of patients seen for the first time when in labour, the alternatives of craniotomy and symphysiotomy will sometimes have to be considered even when the child is living. There is no doubt that it is better to perform craniotomy than to attempt to deliver a living child by Cæsarean section hurriedly undertaken, with insufficient antiseptic preparations, in insanitary surroundings, or by an operator unaccustomed to the technique of aseptic surgery. And further, it may be wiser to perform craniotomy than Cæsarean section when repeated unsuccessful attempts have been previously made to deliver through the natural passages; for apart altogether from the possible risk of infection having occurred, the chances of

the survival of the child, even if delivered alive by Cæsarean section, have been necessarily prejudiced by repeated and prolonged attempts to extract it with forceps through a narrow pelvis. Cranial injuries such as meningeal hæmorrhage may thus be caused, from which the child will almost inevitably die in a few days, even if born alive. Inasmuch as the operation would be undertaken solely with the object of rescuing the child, the fact that its survival has been already gravely prejudiced must not be overlooked.

If there are any positive signs of infection having occurred, such as offensive smell of the liquor amnii, or fever associated with signs of illness or exhaustion on the part of the mother, the child's life should unhesitatingly be sacrificed, Cæsarean section in such a case being an extremely dangerous operation. Intra-uterine infection during labour speedily causes the death of the child from spread of the infection, and by the time the above-mentioned evidences of infection are observed the fœtal heart sounds have usually ceased.

It is usual to divide the indications into *absolute* and *relative*. In the former a degree of obstruction is present which absolutely prohibits delivery by any method through the natural passages ; therefore Cæsarean section must be performed whether the fœtus is dead or alive ; in the latter, delivery by the natural passages, though perhaps difficult, is possible, and the operation is resorted to from choice, not necessity.

Absolute Indications.—(1) Extreme degrees of pelvic contraction, the conjugate diameter of the brim being not more than 2 inches, or the area of the plane of the brim not more than 2 × 4 inches (5 × 10 cm.).

(2) Insuperable obstruction from—

(*a*) Tumours of the uterus, such as cancer of the cervix, and fibroids of the lower uterine segment or cervix.

(*b*) Other tumours, impacted in the pelvis, which cannot be removed by vaginal or abdominal section, without first extracting the fœtus from the uterus.

(*c*) Tumours of the pelvic bones.

(*d*) Undilatable atresia of the cervix or vagina.

Relative Indications.—(1) Certain degrees of *pelvic contraction* or of *obstruction* from other causes, as an alternative to craniotomy, symphysiotomy, or induction of premature labour (conjugate of the brim from 2 to $3\frac{1}{2}$ inches—4 to 8·75 cm.).

(2) *Fibroid Tumours* which threaten to cause, or are actually causing, some degree of obstruction in labour. In addition to overcoming an obstruction, Cæsarean section gives an opportunity of dealing at the same time with the fibroid tumour. The ideal procedure is to enucleate the fibroids from the uterine wall, after extracting the child, and then to close the incisions and conserve the uterus. This is, however, not always practicable, and removal of the uterus must then be carried out.

Ovarian tumours obstructing labour may be dealt with by Cæsarean section. If the tumour is fixed in the pelvis, it may be impossible to separate and remove it without first reducing the size of the uterus by extracting the child. The ideal procedure in such cases is to remove the tumour first, and then to deliver *per vagina* without opening the uterus.

(3) *Urgent maternal complications* sometimes call for delivery by Cæsarean section. Reference has been already made to its use in eclampsia, in placenta prævia, in accidental hæmorrhage, and in heart disease. In some of these conditions, *e.g.*, in eclampsia and in heart disease, the use of a general anæsthetic constitutes one of the chief risks of the operation, and one of the great objections to it. Some method of local anæsthesia should therefore be employed whenever possible ; the spinal method is suitable, or if the operator is unfamiliar with the technique of this procedure, the so-called " shockless method " of Crile may be made use of. This consists in infiltrating the abdominal wall with a weak solution of novocain and quinine-urea-hydrochloride, which destroys sensation and produces complete muscular relaxation in the infiltrated area. A very small amount of a general anæsthetic is usually combined with it, sufficient to suspend consciousness.

(4) Death of the mother, the operation being undertaken immediately after death for the purpose of extracting a living child.

Cæsarean section during labour should not be performed if the conditions indicate that the survival of the child is unlikely—*e.g.*, marked slowing of the fœtal heart (under 100), or fixation with marked moulding of the head in a contracted brim. In the former case it is very unlikely that the child will be extracted in time to save it since it has either been seriously injured or has become deeply asphyxiated ; in the latter the extent of the injury the head has sustained is probably serious and the survival of the child doubtful. When, in addition to evidence of fœtal injury or asphyxia, there is also a probability of infection having occurred, Cæsarean section must be held to be contra-indicated. To expose the mother to the increased risk associated with the operation under these conditions, when the survival of the child is already prejudiced, is not justifiable ; the old obstetric principle should be followed that when the chances of life of the mother and those of the child are definitely conflicting, the child should be sacrificed.

Indications for Removing the Uterus.—After Cæsarean section removal of the uterus may be necessitated by the following conditions :

(1) Uterine infection. It is a wise precaution to remove the uterus whenever there is reason to believe that the uterine cavity has become infected. The reason for removing the uterus lies in the great risk of septic peritonitis which the mother runs if the infected organ is left. It is quite practicable, by careful technique, to avoid infecting the general peritoneal cavity with liquor amnii, etc., during the operation (*vide infra*). But if the uterine tissues are infected the incision in the uterus will not heal, infective material will pass into the peritoneal cavity, and general peritonitis will result. In some such cases localised suppuration has occurred between the anterior uterine wall and the abdominal parietes, resulting in a utero-parietal fistula. When infection of the parturient uterus occurs it is probable that the infection is not for long limited to the amniotic cavity, but rapidly spreads to the tissues of the uterine wall itself. The danger of peritoneal infection is therefore not confined to the operation, but remains when the uterus has been sewn up and returned to the abdomen.

(2) Disease of the uterus, such as malignant or fibroid

tumours, or malformation, for which hysterectomy would be indicated under any circumstances.

(3) The uterus may be removed along with the appendages in osteomalacia.

(4) When insuperable and incurable obstruction is present, for the purpose of preventing subsequent conception.

The Operation.—When it is necessary to perform the operation hurriedly, owing to the cause of obstruction being undiscovered until labour is advanced, the prognosis is distinctly less favourable than when sufficient time is available for proper preparations to be made. The gravity of the prognosis may be said, under such circumstances, to be influenced chiefly by the duration of labour and the risk of the uterus having been infected. We have here another illustration of the importance in pelvic contraction of making an accurate diagnosis of the *degree* of contraction, so that harm may not be done by resort to methods of delivery which cannot possibly be successful. Naturally also the longer the patient has been in labour the more unfavourable becomes the prognosis for the child. It was formerly thought necessary to wait for the onset of labour pains and the commencement of dilatation of the cervix, but experience has shown that there is no advantage in so doing. When the operation is performed before labour has begun, some operators advise that the cervix should be artificially dilated until three fingers can be passed through the internal os in order to provide a channel for the free escape of the lochia. Experience has abundantly shown that this is quite unnecessary ; the amount of lochia is usually small, and the after-pains which follow the operation accomplish all the cervical dilatation which is required. The prognosis is best both for mother and child when the operation is performed without waiting for the onset of labour, and when there is ample time for proper preparations to be made.

The *general preparations* necessary are those ordinarily required for abdominal section.

The *local preparations* include the vagina and the abdominal wall. Preparation of the vagina is unnecessary when the parts are healthy and labour has not commenced ; when labour has been already for some time in progress

the canal should be disinfected as for a vaginal operation. Preliminary antiseptic douching is useful, but reliance must be placed chiefly on careful swabbing of the cervix and vaginal walls with tincture of iodine. This should be done with the aid of a speculum, and may be repeated immediately before the operation is begun. The surfaces must be wiped free from their secretions with pledgets of sterile cotton wool before applying the iodine.

The skin of the abdominal parietes should be sterilised from twelve to twenty-four hours before the operation, and carefully protected. When the operation is performed as an emergency, the following method will suffice : After shaving down to the pubes, the skin is well scrubbed with soft soap and hot water for five minutes, special attention being paid to the umbilicus ; the soap is then washed off with fresh hot water, and ether poured over the skin and rubbed in with a swab. When the skin is dry it is thoroughly swabbed with tincture of iodine.

The best anæsthetic is chloroform, which is particularly well borne by pregnant women, and affects the fœtus less profoundly than ether, owing to its lower diffusibility. An intra-muscular injection of ergotin or aseptic ergot may be made into the buttock as soon as the patient is anæsthetised ; this will assist proper retraction of the uterus after its evacuation. Before commencing the operation the presentation and position of the fœtus should be determined by palpation, and evidence obtained that it is alive, as Cæsarean section for ' relative ' indications is only justifiable when the fœtus is living. An extra assistant should be at hand, and a warm bath prepared, to resuscitate the fœtus if it should prove to be asphyxiated.

The *abdominal incision* should be made about 5 inches long in the middle line, starting about 2 inches above the umbilicus (Fig. 345). It will be recollected that the abdominal parietes at term are very thin, and the incision must be made with care, or all the layers may be unexpectedly divided by the first cut. Under normal conditions liquor amnii is sterile, and its escape need not be feared. When operating during labour precautions should be taken against peritoneal contamination by packing gauze between the uterus and the abdominal wall all round the incision.

The *uterine incision* should be about 4 inches long, and as nearly as possible in the mesial plane of the uterus (Fig. 344).

FIG. 340.—Cæsarean Section. Extracting the child by the feet; the operator's left hand is assisting the delivery of the head; the uterus is being steadied by the two hands of an assistant.

It is therefore advisable to insert the hand and rotate the uterus if it is obvious that its anterior surface lies obliquely. The uterine incision should be made to correspond with the upper 4 inches of the abdominal incision; this will avoid the

lower uterine segment altogether, and there will be no risk of injuring the bladder. Free hæmorrhage will usually occur, which, however, may be neglected for the moment. The membranes should be first exposed by a small incision, which can be extended by dividing the uterine wall upwards and downwards with scissors; the amniotic sac is then opened and the hand passed to the breech, the position of which has been previously determined by palpation. The

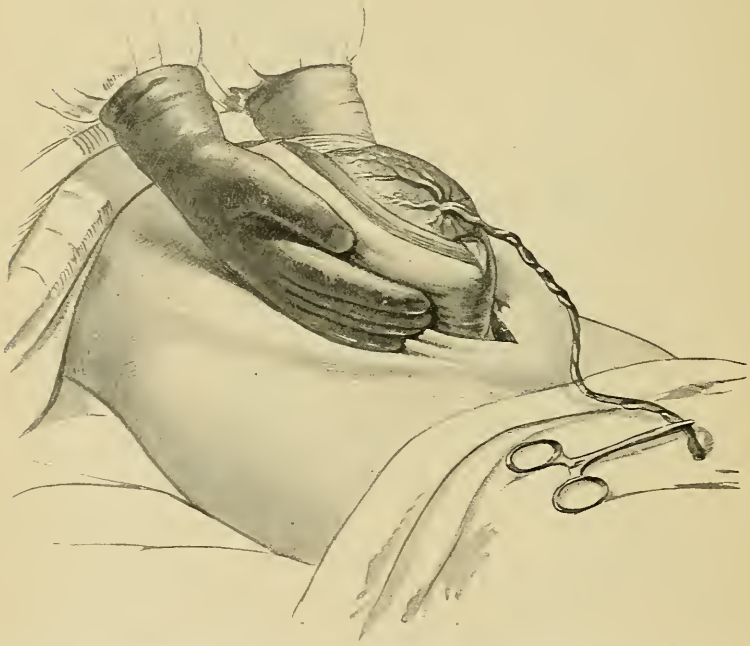


FIG. 341.—Cæsarean Section. The child has been extracted, and the after-birth is being squeezed out of the uterus.

fœtus is then seized by the feet and delivered breech first (Fig. 340); the cord is immediately clamped and divided, and the child handed over to the care of an assistant. If the placenta lies upon the anterior wall profuse bleeding will occur from the first cut in the uterus, but without pausing the operator should tear through the placental tissues with two forefingers, open the amnion and extract the child as rapidly as possible, when the hæmorrhage can be brought under control. This is a much more rapid method than the

plan usually recommended of detaching the placenta on both sides of the incision and pulling it out of the wound before extracting the child. Until the child has been extracted the operator must work rapidly, for loss of time involves not only free bleeding but also risks of fœtal asphyxia.

As soon as the child has been extracted the operator's assistant passes his hand behind the fundus, turns the re-

Fig. 342.—Cæsarean Section. Squeezing the uterus through a hot sterilised towel to promote contraction.

tracted uterus out of the abdominal wound, and squeezes it firmly in a hot towel to control bleeding. The intestines are then protected with sterilised towels or large swabs, and the placenta and membranes *carefully* and *completely* peeled off the uterine wall. If labour has not commenced, the finger should be passed through the cervix, to see that there is sufficient space for free drainage of the lochia.

Closing the Uterine Incision.—Free hæmorrhage occurs from the cut surfaces of the uterine wall in which large

venous sinuses and sometimes arteries of considerable size have been divided. This hæmorrhage can be temporarily arrested by wrapping up the uterus in a sterilised towel wrung out of hot saline solution, and then moulding it firmly between the hands as shown in Fig. 342. This produces fairly good retraction of the uterine muscle by which

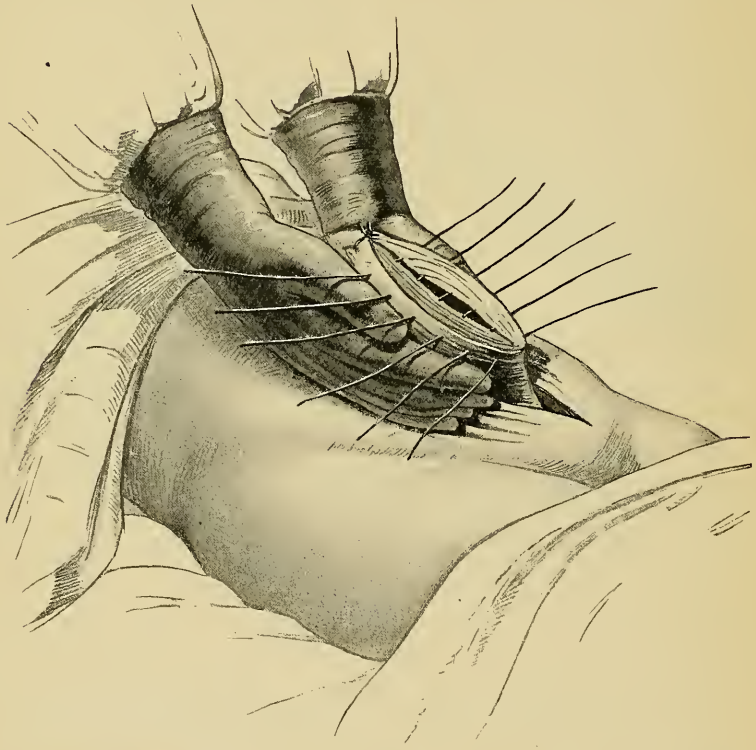


FIG. 343.—Cæsarean Section. The deep sutures have been introduced, but only the top one has been tied.

the bleeding is to a great extent controlled ; the effect lasts for two or three minutes, during which sutures can be introduced, and the manipulation of the uterus can then be repeated if necessary. Bleeding can also be controlled to some extent by placing a pair of intestinal clamps on each broad ligament, outside the ovary, as soon as the uterus has been turned out of the abdomen. It is, however, difficult to

effectually compress the uterine arteries owing to the depth at which they lie, and the former method will be found more effectual.

Suturing the uterine incision is the most important step in the operation, and it must be carefully carried out. The method of Sänger is in general use for this purpose. Two

Fig. 344.—Cæsarean Section. The uterus has been closed with alternate deep and superficial sutures.

series of sutures are employed, the deep and the superficial. The deep sutures are placed at intervals of about three-quarters of an inch, the two end stitches including the angles of the incision. Each suture may be made to include the whole thickness of the uterine wall, being introduced about one-third of an inch outside the cut edge on the peritoneal surface, and made to emerge on the uterine surface near the edge of the incision (Fig. 343); the needle

is then re-introduced upon the uterine surface of the opposite side and brought out at a point about one-third of an inch outside the cut edge on the peritoneal surface. When tied this suture will firmly approximate the cut surfaces through their whole thickness. The sutures may be tied one by one as they are introduced, or the whole series of deep stitches may be introduced before any are tied. The latter method allows of the cut edges being everted and held together by an assistant while the sutures are being introduced. The deep stitches must be firmly tied so as to produce considerable tension (Fig. 344).

After the deep stitches have been tied, the uterus should again be manipulated with a hot towel to produce retraction, and the superficial stitches can then be introduced. One or two may be required in each interval between the deep stitches. They should be made to take up about half the thickness of the uterine wall, and should be tied with as little tension as possible.

The ideal suture material is catgut specially hardened by the chromic acid or the formalin-iodine process. A stout ligature is required for the deep sutures (No. 4), and a finer one for the intermediate sutures (No. 2). Silk or thread may, however, be used instead of catgut.

Closure of the Abdominal Wound.—The uterus is now returned to the abdominal cavity, and all blood or other fluid must be cleared away from the flanks and the pouch of Douglas, or wherever it may be found. Before returning it, the uterus should be again firmly squeezed in a hot sterilised towel to expel any blood from the cavity which may have accumulated during the suturing of the incision. If the uterus does not retract properly it can be massaged, or hot sterile saline solution (0·75 per cent.) poured over it. It is preferable, if possible, to sew up the abdominal wound in three layers, in the usual manner ; but owing to the thinness of the parietes this is not always practicable. The peritoneum may then be closed with a continuous catgut suture, and the other layers, including the aponeurosis and the skin, taken up with interrupted silk or silkworm-gut stitches.

The technique just described is suitable for all cases in which the operation is performed before labour, or early in

labour, when there is no risk of infection having occurred. When the operation is performed after labour has been already prolonged, or after unsuccessful attempts to deliver with forceps have been made, stringent precautions should be taken to avoid infecting the general peritoneal cavity when emptying the uterus. The technique of the operation should then be modified in the following manner :

The parietal incision should be prolonged upwards to a length of about 8 inches, when the entire uterus can be eventrated through it. The abdominal cavity is then carefully

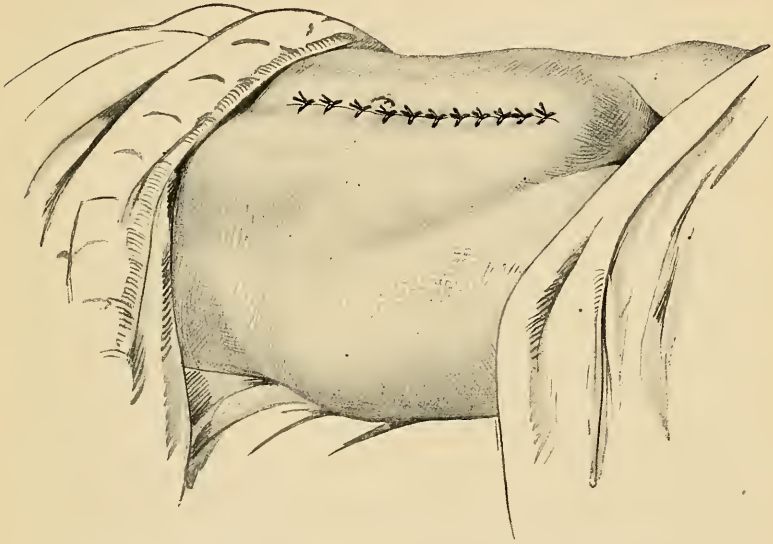


Fig. 345.—Cæsarean Section. The closed abdominal incision.

packed off with sterilised towels and large abdominal pads wrung out of warm sterile saline solution. Similarly the utero-vesical pouch and lateral pelvic regions are packed, and the edges of the abdominal wound protected in the same manner. The uterus can then be opened either by a median anterior incision placed rather higher up than that just described, or by a transverse incision across the fundus (incision of Fritsch). After emptying the uterus, the uterine cavity may be swabbed out with weak lysol solution (3j. to Oj.), and the incision then closed by Sänger's method. The surface of the uterus is next freely irrigated with normal

saline solution, the packing is removed, and the uterus allowed to drop back into the abdominal cavity. Finally the operator and his assistant put on a fresh pair of boiled rubber gloves, and a fresh set of instruments should be used in closing the abdominal wound.

Sterilisation of the Patient.—It is seldom justifiable to sterilise a patient after conservative Cæsarean section. This operation has now been performed with success as many as five times upon the same patient, and the risks attending it are so small that permanent mutilation in order to avoid the risk of a second operation should be discouraged. Pregnancy following Cæsarean section usually runs a normal course ; in very rare instances spontaneous rupture through the uterine cicatrix either before or during labour has been reported. (Fig. 243.) Sterilisation is therefore rarely required, except for local incurable disease.

Sometimes, however, it may be necessary to sterilise a healthy woman from unwillingness on her part to undergo operation again. This may be accomplished either by removing the uterus or by removing the whole of both Fallopian tubes. The removal of the ovaries for this purpose is unjustifiable unless these organs are grossly diseased, or the patient is the subject of osteomalacia, for double oöphorectomy is often followed by serious consequences in women under forty-five years of age. The removal of the uterus is objectionable in women less than forty-five years of age, inasmuch as it involves permanent arrest of menstruation. The removal of the Fallopian tubes has no influence whatever upon the menstrual functions. It is necessary to remove them in their entirety to ensure sterility, and to close the peritoneum over the stump at the uterine end. It has been shown that ligation of the tubes alone, or ligation and division, or even excision of a portion of the tubes, may be followed by conception, through subsequent restoration of the tubal lumen.

The *after-treatment* of Cæsarean section is much the same as that of abdominal section generally. The skin sutures should be removed on the tenth day, and the patient should be kept in bed for two to three weeks. The amount of lochial discharge is usually small, and the involution of the uterus is not unfavourably affected. The patient may be

Uterus removed by Cæsarean Hysterectomy for Cancer of the Cervix. Placenta *in situ*. Below is a portion of the growth which was removed prior to the operation. (From the collection of Dr. Cuthbert Lockyer.)

quite able to suckle her child, and should be encouraged to do so.

Cæsarean Hysterectomy.—This operation is performed in the same way as conservative Cæsarean section up to the point of extraction of the fœtus. The uterus may then be amputated at the level of the internal os, or the whole organ, body and cervix, may be removed.

Supra-vaginal Amputation.—The ovarian vessels on each side are first secured with two ligatures, so as either to remove or to leave the ovaries as may be desired ; in patients under forty-five both ovaries, if healthy, should be left. Then the round ligaments are similarly ligatured. The broad ligaments, first one and then the other, are clamped close to the uterine border, and divided between the clamp and the ovarian ligature down to the level of the internal os. Next an anterior peritoneal flap is mapped out and turned down along with the bladder ; this allows the uterine arteries to be secured and divided at the level of the internal os close to the uterine wall. The uterus is then amputated ; after the uterine arteries have been tied and all oozing from the stump has been stopped, the peritoneal edges are united over it by a continuous suture running from one ovarian artery across the pelvic floor to the other.

Panhysterectomy.—This operation is performed in the manner just described up to the point of securing and dividing the uterine arteries. The cellular tissue is then pushed down all round the cervix until the reflection of the vaginal vault is reached. The anterior vaginal fornix is then opened with knife or scissors and the incision carried completely around the cervix, when the uterus, being freed, can be lifted out. All oozing from the cut edges of the vaginal wall must be carefully controlled ; a gauze pad is then pushed down into the vagina, and the peritoneum closed over it with a continuous suture from one ovarian artery to the other.

Supra-vaginal amputation is preferred by most operators, but total hysterectomy will be required for septic infection of the uterus or for malignant growths of the cervix (Plate V.), and in some cases for fibroids.

Vaginal Cæsarean Section.—This operation consists in extracting a viable child through an undilated cervix by

means of one or more deep incisions extending into the lower uterine segment. It has been already mentioned as a method of *accouchement forcé*. It is not available in cases of pelvic contraction or any other form of obstruction, consequently its utility is greatly limited in comparison with abdominal methods of opening the uterus. It has been employed chiefly in cases of eclampsia, and was indeed introduced by Dührssen as a method of dealing with that complication.

The technique of the operation is more difficult than that of abdominal Cæsarean section, and it is very doubtful whether there are any compensating advantages. When the fœtus is small, *e.g.* up to the thirtieth week, the difficulties are of course much smaller. Inasmuch as the cases in which it has been performed have been, as a rule, cases of eclampsia of great severity, the apparent mortality of the operation is very high. But it must be recollected that in such cases death would be very likely to occur from toxæmia quite independently of the method of delivery adopted.

Extra-peritoneal Cœsarean Section.—This new and comparatively untried procedure consists in reflecting the peritoneum from the lower part of the anterior surface of the uterine wall, and then extracting the child through a transverse incision through the lower uterine segments. The general peritoneal cavity is not opened, or if opened is again closed before making the uterine incision, by stitching the reflected peritoneal flap to the parietal peritoneum as high up as possible. It was designed to avoid the risk of peritoneal infection when opening an infected uterus by the classical method of Cæsarean section.

Prognosis of the Cœsarean Operations.—From statistics of cases of Cæsarean section by British operators collated by Amand Routh, it appears that the mortality of the operation during the five years 1906 to 1910 was 6·1 per cent., as estimated from 602 operations. This represents the general maternal mortality which follows the operation as performed at the present time. But it must be recollected that the whole of this mortality is not due to the operation ; a part must be attributed to pre-existing maternal complications, or to other unfavourable conditions which were present. It has been already mentioned that when the operation is

performed late in labour, and after unsuccessful attempts to deliver with forceps have been made, the prognosis is not so favourable as when the operation is performed before labour. This point is illustrated by Routh's statistics, which show that 469 cases operated on, either before labour, or, at any rate, before rupture of the membranes, had a mortality of only 2·9 per cent.—*i.e.*, less than one-half of the mean mortality of the whole. But 230 cases operated on after rupture of the membranes, and in some cases after prolonged labour, showed a mortality of 17·3 per cent.

Further, it will be obvious that Cæsarean section for grave maternal disorders such as eclampsia must necessarily yield a percentage of mortality greatly in excess of the true mortality of the operation.

The fœtal mortality, which is, of course, influenced to some extent by the same considerations, is placed by Routh at about 8 per cent.

Craniotomy, Decapitation, and Evisceration

These operations are designed to reduce the bulk of the fœtal head or trunk so as to allow of its extraction through the genital canal. Recent improvements in other obstetric operations have greatly restricted the indications for destruction of the fœtus *in utero*, and there is now a general agreement that the destructive operations should not be performed upon a living fœtus, unless the circumstances of the case render any alternative procedure positively dangerous to the life of the mother. They will, of course, continue to hold their position as the safest means of delivering a dead fœtus in certain degrees of pelvic contraction, or in other forms of obstruction or difficult delivery. In the case of a living fœtus the alternative procedures of symphysiotomy and Cæsarean section should be carefully considered, and only when the circumstances of the case are such as to increase greatly the average risk of these operations can it be justifiable to destroy a living fœtus in order to deliver it.

A. **Craniotomy.**—This term includes the various methods of reducing the size of the fœtal head.

Indications.—(*a*) Obstruction of extreme degree, from pelvic contraction, from atresia, or from tumours of the soft

parts, when the child is dead or Cæsarean section is refused or is unlikely to succeed in saving the child's life. Unless the conjugate of the brim is at least $2\frac{1}{2}$ inches, extraction of a full-time fœtus is always very difficult; if, however, as in a flat pelvis, the transverse diameter is relatively long, success may be obtained with a conjugate of rather less than $2\frac{1}{2}$ inches. It is generally agreed that craniotomy should not be attempted unless the pelvic brim measures at least 2 inches by 4 inches (6·5 cm. by 10 cm.). (*b*) Conditions under which delivery by forceps or version would be practicable, but difficult, and the fœtus is dead. As examples may be mentioned, an impacted shoulder presentation, irreducible posterior positions of the occiput in vertex and breech, or of the chin in face presentations. (*c*) Malformations of the fœtal head, such as hydrocephalus. (*d*) Urgent maternal complications necessitating rapid delivery with the minimum of maternal risk—*e.g.*, eclampsia and hæmorrhage.

When the indications for craniotomy arise, the patient's general condition has usually suffered from prolonged labour, and vaginal and perineal lacerations are also often met with from previous unsuccessful attempts to deliver with forceps. In these circumstances septic infection is liable to occur, and stringent antiseptic precautions should accordingly be taken. The vulva should be shaved, and the vaginal canal and vulva thoroughly cleansed, first with liquid soap and hot water, and then with an antiseptic solution of moderate strength, such as biniodide of mercury 1–2,000, or lysol ʒj. to Oj. The bladder should then be emptied by catheter, and the operator should wear sterilised rubber gloves.

The operation of craniotomy consists of the two stages of (1) *Perforation;* (2) *Crushing and Extraction.*

(1) Perforation.—This stage consists in opening the cranial cavity and evacuating its contents. The instrument required is the *perforator;* many varieties are obtainable, but the most useful is that of Oldham (Fig. 346). The blades of this perforator end in a sharp point, and are each furnished with an outer sharp cutting edge about 1 inch in length, ending in a projecting ridge or *shoulder.* The blades themselves are straight and furnished with strong handles,

separated widely from one another when the blades are closed. When the handles are pressed together the cutting edges are forced apart.

In perforating the fore-coming head the parietal bone should be selected for the operation ; in the case of the after-

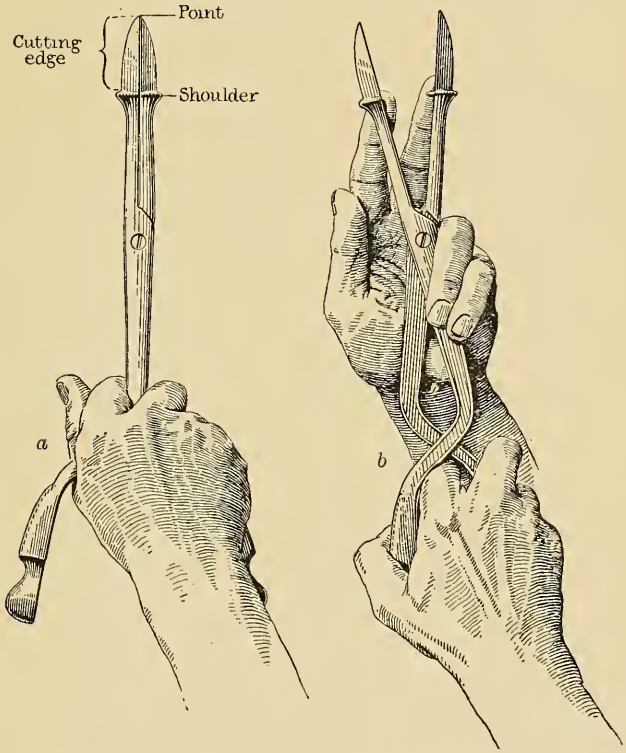


Fig. 346.—*a*, How to hold the Perforator when closed ; *b*, How to open the Perforator.

Note.—Gloves should as a rule be worn in using this instrument.

coming head it is usually most convenient to perforate the occipital bone. In the case of a face presentation it may be necessary to perforate the roof of the mouth or the orbit. The instrument, with blades closed, is held firmly in the crook of the handles (Fig. 346, *a*) and the fingers of the other hand are passed up to the spot selected for perforation ; the instrument is then introduced along the palm of this hand, care

being taken to protect the vaginal walls from the cutting edges. An assistant is required to immobilise the head by suprapubic pressure when it is not fixed in the brim. The point is then firmly pressed against the head, and by a rotary movement is made to penetrate the bone until arrested by the shoulders of the perforator. Care must be taken to prevent the point from slipping, the fingers of the internal hand keeping it in contact with the head. The grip is then transferred to the handles, and as these are forced together the bone is lacerated by the cutting edges, two fingers of the internal hand being kept in contact with the shoulders (Fig. 346, *b*). The instrument is then closed, rotated through a right angle, and the bone cut again in a direction across the first. The head of the perforator can now be slipped inside the cranial cavity, and the brain, including the vital centres in the medulla, thoroughly broken up. It must be remembered that the strong tentorium cerebelli must be pierced in order to reach the medulla. By suprapubic pressure the greater part of the cranial contents can now be expressed ; or they may be completely cleared out with the finger and a stream of boiled water if desired.

Perforation is an operation of great simplicity except in cases of non-engagement, when the head is so high up as to be difficult to reach with the fingers, and accordingly it is more difficult to keep the perforator under control. Should the perforator slip, the uterine wall may be lacerated by the points, and in some instances injury to the sacrum has been caused in this manner. When, after an unsuccessful attempt to deliver with forceps, craniotomy is decided upon, the perforator should be used before removing the forceps ; this holds the head very steady, and after perforation it can sometimes be extracted with the forceps—*vide infra.*

If the operation has been performed upon the after-coming head, traction on the trunk, combined with suprapubic pressure, will suffice for delivery of the perforated head, unless the degree of pelvic contraction is extreme, when crushing will be required. With the fore-coming head extraction is more difficult, and a preliminary crushing is generally advisable.

When the amount of pelvic contraction is small, perforation and removal of the cranial contents may reduce the size

of the head sufficiently to allow it to come through without crushing. The child may then be delivered by version if the local conditions are favourable for this operation, and the conjugate measures at least 3 inches, the pelvis being flattened, not generally contracted. In cases in which perforation is performed after the head has passed through the brim, it may be delivered with forceps if the amount of contraction is small, but this instrument must not be used if the head is above the brim.

The perforated head may be extracted with either the cranioclast or the cephalotribe—*vide infra.* In using the former the head is first turned to a face presentation by pulling down the chin with a crotchet hooked into the mouth. Then the female blade is applied over the face, the male blade passed into the perforation aperture, or simply over the collapsed vertex. The method of extraction with the cephalotribe is described below. Munro Kerr recommends the use of the crotchet (sharp hook) as an alternative to the cephalotribe ; this instrument may be passed into the perforation aperture and a firm hold obtained of the irregular bones of the base of the skull. Firm traction may then be applied to the head to deliver it.

It is not necessary to crush the *after-coming head* after it has been perforated, unless the degree of pelvic contraction is extreme. By steady traction on the trunk, aided by fundal pressure, the cranial bones collapse, and the head becomes narrowed and elongated vertically. If difficulty is experienced the cephalotribe may be applied.

(2) **Crushing and Extraction.**—The amount of crushing required is determined by the available pelvic space. Two degrees must be described :· (*a*) simply crushing the skull (*cephalotripsy*) ; (*b*) removing the vault and then crushing the face (*cranioclasm*). As extraction is performed with the crushing instruments, crushing and extraction may be considered together.

(*a*) *Cephalotripsy.*—The best form of cephalotribe is that of Braxton Hicks (Fig. 347). It is a pair of very powerful forceps, the blades of which are thick and narrow, with a slight pelvic curve. When closed they are in contact by their incurved tips ; the maximum distance between them does not exceed $1\frac{1}{2}$ inches. The handles are locked like the

forceps, and furnished with a powerful screw, by means of which the blades can be forced together and the head crushed between them. The instrument is applied in the transverse diameter of the pelvis in the same manner as the forceps; when the pelvis is flattened this implies that the head will be seized in the antero-posterior diameter, one blade passing over the face, the other over the occiput. This grip is the most secure which can be obtained and the most effective, inasmuch as the reduction in size which it produces is greater than where the head is gripped in any other diameter. If the head is not engaged in the transverse diameter of the pelvis the grip of the instrument will be oblique, and not only less secure, but also less effective in reducing the size of the head. In the generally contracted pelvis the oblique engagement of the head and the relative narrowness of the transverse diameter of the pelvis render the use of the cephalotribe more difficult than in a flat pelvis.

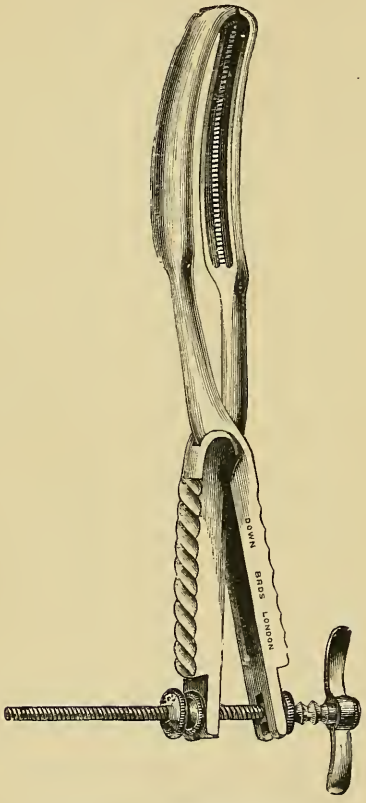


FIG. 347.—Cephalotribe of Braxton Hicks.

On account of the narrowness and great weight of the blades, it is much more difficult to prevent them from slipping, and great care must be taken to direct each blade into its proper position and keep it there with the fingers. When the blades have been applied and the handles locked, the screw is adjusted and crushing begun. The blades are now liable to slip backwards off the head, unless care is taken to keep the instrument in the axis of the brim and retain the blades in

their proper position in contact with the head. The screw should be slowly tightened until the handles are nearly in contact, while the internal fingers take note of the position of the blades. If the amount of resistance encountered by the screw is small, this generally means that the blades are slipping and the head is not being properly crushed. They should then be unscrewed and re-applied, care being taken to pass one of the blades well over the face, which usually gives a secure grip. When the handles have been well screwed together the crushing is completed.

It will be observed that the crushed diameter of the head now lies in the transverse of the pelvis; delivery will be facilitated in a flat pelvis if the instrument is rotated so as to bring the crushed diameter into the conjugate where the space is limited. The amount of pelvic curve on the instrument is slight, and does not contra-indicate extraction in the conjugate.

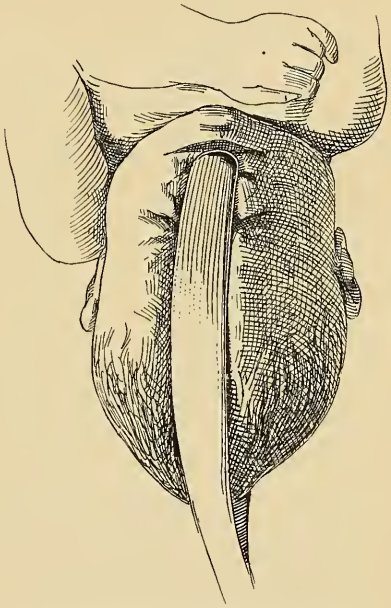


Fig. 348.—The Cephalotribe applied to the Head for Crushing.

Extraction.— Before beginning the extraction the perforation aperture must be examined and the edges of the scalp turned in over the edges of the bone, so as to avoid laceration of the vaginal walls by protruding spicules. Traction should always be made in the axis of the pelvis. The cephalotribe is a very powerful tractor, and at first great gentleness must be used until it is clear that the grip is secure. If traction does not cause the head to advance, the blades are probably slipping. An antiseptic intra-uterine douche should always be given after crushing operations.

The application of the cephalotribe to the after-coming head needs no separate description.

A three-bladed cephalotribe has been introduced by Winter and modified by Auvard. The middle blade is first passed into the perforation aperture ; this is held in position by an assistant while the first outer blade is passed—

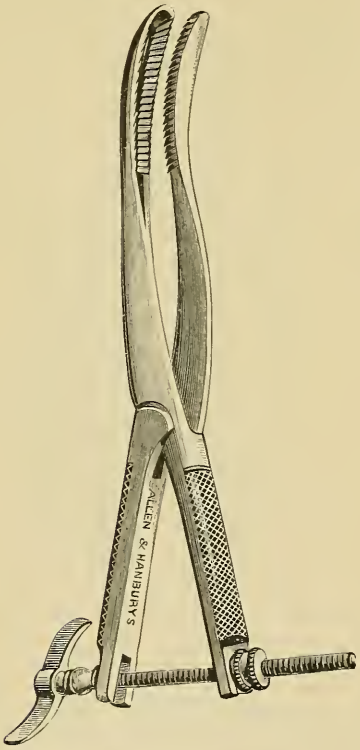


Fig. 349*a*.—Cranioclast.

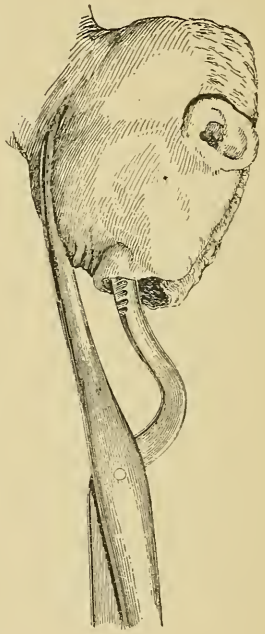


Fig. 349*b*.—Cranioclast applied to the Face after Removal of the Vault of the Skull.

preferably over the face. These two blades are then screwed up, thus crushing the anterior part of the head. Then the second outer blade is passed—over the occiput, and screwed up in turn to the middle blade. The grip thus obtained is very firm, and the amount of reduction of the head is greater than that obtained by the ordinary cephalotribe.

(*b*) *Cranioclasm*.—This operation consists in the avulsion

of the bones of the cranial vault, followed by crushing the remaining part of the head—*i.e.* the face. It is probably never really required unless the conjugate is reduced to $2\frac{1}{2}$ inches or less.

The cranioclast or craniotomy forceps consists of a pair of concavo-convex blades, the outer or larger of which (Fig. 349*a*) is fenestrated, the smaller solid ; their apposed surfaces are strongly serrated. The instrument is powerful but not so heavy as the cephalotribe, and the handles are closed in the same way by a screw. It may be used for traction alone, or for breaking up the vault of the skull (*cranioclasm*). When used for *traction* alone, the small blade is passed into the cranial cavity through the perforation hole ; the outer blade is applied either over the face, the occiput, or one or other parietal bone. The handles are then screwed tightly together and traction begun ; only when the degree of pelvic contraction is moderate can delivery be effected in this way. When used for *breaking up the vault*, the small blade is passed into the cranial cavity, and the large one between the scalp and the bone ; the handles are then screwed up and the portion of bone gripped by the instrument is twisted off and withdrawn. The process is repeated until the vault has been entirely removed. Extraction is then performed by first extending the head by combined vaginal and external manipulations, so as to produce a face presentation ; a sharp hook is then fixed in the jaw to steady the head, and the cranioclast applied over the face, the small blade being passed into the cranial cavity, the large blade beneath the chin (Fig. 349*b*). The bones of the face are then crushed, and the head, now greatly reduced in bulk, can easily be extracted.

Instruments have been devised for the purpose of breaking up the base of the skull after perforation, in cases of extreme pelvic contraction ; this procedure has been called *basilysis*, and the instrument the *basilyst*. Cases of pelvic deformity so extreme as to require this operation are almost always recognised during pregnancy or sufficiently early in labour to permit of Cæsarean section being performed. With the progressive improvement in the standard of obstetric knowledge among midwives and medical practitioners, the necessity for the use of such procedures as these may be expected to disappear.

B. Decapitation.—This operation may be required in impacted transverse presentations, in the case of locked twins, or with double-headed monstrosities. The commonest indication for its performance is a transverse

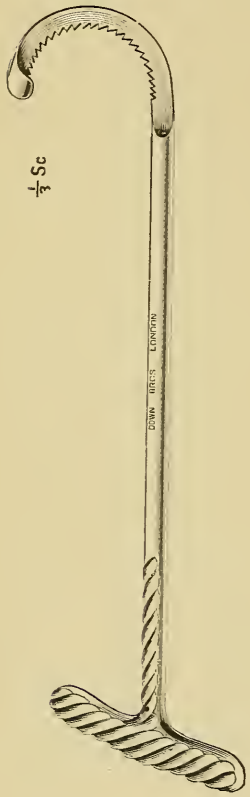


Fig. 350*a*.
Decapitation Hook.

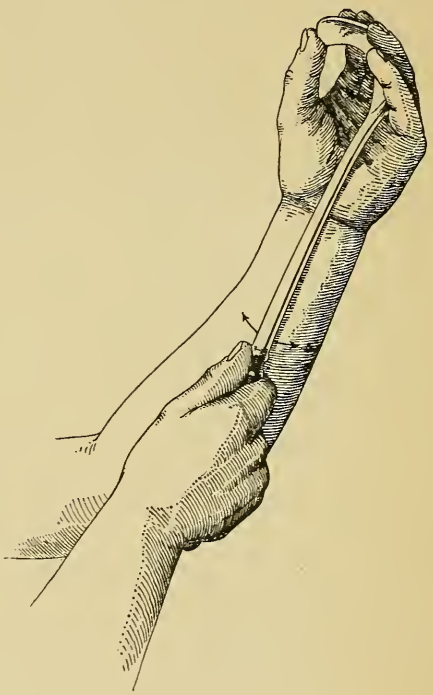


Fig. 350*b*.
How to hold the Decapitation Hook.

presentation in which unsuccessful attempts to deliver by version have been previously made.

It may be performed with a strong pair of curved scissors, but the safest instrument to employ is the decapitation hook (Fig. 350*a*). The one generally used in this country is a wide hook with a blunt point and either a cutting (Ramsbotham's hook) or a serrated edge. The handle is sufficiently long for it to be used when the neck is at the pelvic brim. In

the case of a transverse presentation, decapitation may be performed as follows : If an arm is prolapsed, traction can be made upon it so as to bring the neck down as low as possible. Careful exploration with the fingers having been made to recognise the position of the back and the side to which the head lies, the hook is introduced along the palm of the hand and guided upwards between the shoulder and the anterior pelvic wall (dorso-anterior positions) until the point

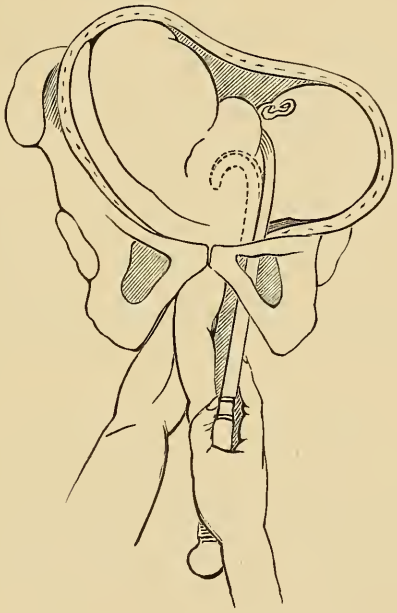


Fig. 351.—Introduction of the Decapitation Hook. (Barnes.)

lies above the neck. It is then rotated through a right angle so as to carry the cutting edge across the neck (Fig. 351) ; the fingers are then passed up the ventral aspect of the fœtus so as to guide the point of the hook into position across the neck. Decapitation is performed by a sawing movement, the fingers of the left hand being kept in contact with the point of the hook to protect the maternal passages from injury. The soft fœtal bones are easily divided in this manner. After severing the head, the trunk is delivered

either by bringing down both arms or by podalic version. When the back presents, it is sometimes necessary to divide the spinal column, in addition to decapitating. Lastly, the retained head may be delivered with forceps, if the pelvis is of normal size, or crushed with the cephalotribe, if the pelvis is contracted; perforation is unnecessary, as the cranial contents will escape through the vertebral canal. In decapitating the after-coming head a long, strong pair of scissors will suffice.

Decapitation may be performed in a somewhat different manner by the use of Braun's hook (Fig. 352). This instrument is blunt, its crook very narrow and ending in a bulbous point. It is intended, not to cut through the neck, but merely to dislocate the cervical vertebræ. It is passed over the neck in the manner already described, and made to

Fig. 352.—Braun's Decapitation Hook.

include the vertebral column; the hook is then forcibly rotated, so as to dislocate the vertebræ. The soft tissues are then divided with scissors. The advantage of this instrument is its small size.

In an impacted shoulder presentation the cord and an arm are usually prolapsed, and by the time the body of the child has become impacted it has ceased to live. Even if feeble pulsation in the cord can still be felt, there is no possibility of delivering rapidly enough to save its life; consequently delivery may be conducted solely in the interests of the mother. If the uterus is retracted, the lower segment distended and Bandl's ring palpable, decapitation is clearly indicated, for version would be attended with the gravest risks of rupture. If the conditions are not quite so unfavourable as this, the uterus may become sufficiently relaxed under surgical anæsthesia to allow of version being

performed, but no unnecessary risk should be run if the child is dead.

When the lower segment is markedly distended, even decapitation is attended by a certain risk of rupture from the introduction of the fingers and the hook. Great care must be exercised, and if difficulty is encountered, decapitation should be abandoned in favour of evisceration.

C. **Evisceration.**—This operation consists in opening the abdomen or thorax with strong scissors in the most accessible position, and removing the abdominal and thoracic viscera piecemeal with the fingers. It may also be necessary to divide the spinal column before the trunk can be delivered. It is indicated in transverse presentation as an alternative to decapitation, and in cases of obstruction from abdominal or thoracic enlargement (ascites, cystic disease of kidneys, &c.).

D. **Cleidotomy.**—This operation consists in dividing one or both clavicles with a strong pair of scissors. Division of the clavicles is sometimes required when, owing to the large size of the trunk or the narrowness of the pelvic outlet, the shoulders cannot be extracted and the child is dead.

Symphysiotomy ; Pubiotomy.

Symphysiotomy consists in dividing the symphysis pubis so as to produce a temporary enlargement of the pelvis sufficient to permit the delivery of a *living child* by the natural passages. Though sometimes performed upon the dead woman during the sixteenth and seventeenth centuries, it was not performed upon the living woman until 1774. Owing to the terribly high mortality of Cæsarean section at this period, symphysiotomy was at first frequently performed ; but it soon fell into disrepute and was practically abandoned, as the results were no better than those of Cæsarean section. More recently it has again been advocated by Morisani of Naples, and Pinard of Paris, but is not generally regarded with favour owing to the extremely limited scope of its application, and the comparatively unfavourable results which it still shows.

The effects of division of the symphysis upon the pelvic diameters are not entirely clear. When, in the cadaver, the pubic bones are separated, a considerable amount of strain

is placed upon the anterior ligaments of the sacro-iliac synchondroses, and these structures may suffer serious injury; in addition, rotation of the innominate bones round a transverse axis passing through these joints occurs, which carries the pubes downwards as in Walcher's position (Fig. 334); lastly, a slight movement of rotation of each innominate bone round its own long axis occurs, which slightly increases the distance between the ischial tuberosities (Sandstein). The pubic bones must not be allowed to separate for more than $2\frac{1}{2}$ inches (Budin and Demelin), or rupture of the sacro-iliac ligaments will occur. This degree of separation increases the conjugate of the pelvic brim by about one-third of an inch, the increase being relatively rather greater in a markedly contracted pelvis than in one only slightly contracted. The oblique diameters of the brim are increased about twice as much, and the transverse about three times as much, as the conjugate. The marked increase obtained in the transverse diameter is, however, of little use without a corresponding increase in the conjugate. The amount of increase obtained at the outlet is probably very small.

Indications.—It is obvious from the above that symphysiotomy can only be applicable to cases of slight disparity between the size of the fœtal head and that of the pelvis. The degree of disparity in any given case is by no means easy to estimate exactly, and as precise measurement of the fœtal head in labour is impracticable, the indication for the operation has to be based mainly upon the length of the pelvic diameters. There is therefore abundant room for error. Unless the conjugate of the brim is at least 3 inches in length there is very little prospect of success; in pelves of greater size than this the prospect of success is better. With these reservations, symphysiotomy may be performed when the head is delayed at the brim in a flat or generally contracted pelvis, or at the outlet in a funnel pelvis, the degree of disparity between the pelvis and the fœtal head being small. It may be preferred to Cæsarean section in cases of this kind when labour is advanced, and repeated attempts to deliver by other means have already been made. But if the passages have become infected during labour, symphysiotomy is attended by grave risks of septic infection of the wound; and although this does not communicate with the genital canal,

serious and even fatal results may follow from the spread of the infection to the pelvic cellular tissue and the vesical venous plexuses.

If the fœtus presents by the breech, it is impossible to estimate the relative sizes of head and pelvis until the body is born, when there is no time to perform symphysiotomy ; therefore the operation is only of use in head presentations. If the fœtus is dead, craniotomy should always be preferred.

The Operation.—*Preliminaries.*—The time for performance of the operation is at the end of the first or early in the second stage of labour ; if necessary, dilatation may be hastened by de Ribes's bag. The operator must, of course, satisfy himself that the child is alive. The pubes should be shaved and the abdominal wall and vulva disinfected. The operator requires three assistants, two of whom will support the thighs of the patient, who should be placed in the dorsal position, with the buttocks over the edge of the bed or operating table.

The operation may be performed by the *open* or the *subcutaneous* method.

Open Method.—(1) An incision 2 or 3 inches long is made in the middle line from a point just above the pubes to the lower border of the symphysis, avoiding the clitoris ; this incision passes down to the bone, and in its upper part exposes the aponeurosis. By blunt dissection the clitoris is pushed downwards, and its suspensory ligament then separated from the pubes by cutting through it with scissors ; vessels divided at this stage must be carefully secured. The index finger is next passed behind the symphysis, and worked downwards in the cellular tissue until the lower border is reached ; when the head is engaged in a narrow brim, this may be rather difficult. (2) The assistant passes a sound into the urethra so that its position may be readily located, and the operator divides the fibro-cartilage of the symphysis with a probe-pointed knife from above downwards. Sometimes the joint is not precisely in the middle line, and it will be necessary to explore to either side in order to find it. In cutting the lower part of the joint it is better to incline the knife to one or other side, so as not to injure the urethra. After the fibro-cartilage has been divided the bones are still held together by a strong band of fibrous tissue, the sub-pubic

ligament, which runs across the pubic arch immediately below the joint. This ligament must now be divided with care, for immediately beneath it lies the terminal branch of the internal pudic artery. (3) The pubic bones now separate spontaneously, and the two assistants in charge of the legs abduct the flexed thighs gently until the required amount of separation is obtained ; this must be measured, not guessed. The wound is then plugged with antiseptic gauze and the legs held perfectly steady during the remainder of the operation. (4) This consists in the delivery of the child, which is best done with forceps ; great care must be exercised, for if much force is exerted serious injury will be done to the pelvic joints and the urethra. If the placenta is delayed, it is better to remove it by the digital method. (5) The wound is then closed with four or five deep silkworm-gut sutures, and an antiseptic dressing applied. It is unnecessary to suture the bones, but a tight pelvic binder is applied in such a position as to immobilise the innominate bones and thighs. Some operators advise that the vagina should be plugged with antiseptic gauze. A catheter should be passed immediately after the operation to make sure that the urethra has not been injured : if laceration has occurred a soft rubber catheter should be tied in for forty-eight hours.

Subcutaneous Method.—A small incision down to the bone is first made with a tenotomy knife in the middle line just below the clitoris, which should be pulled upwards as much as possible. A curved probe-pointed bistoury is then inserted under the soft tissues and passed upwards nearly to the upper border of the symphysis, cutting into the front of the cartilage. The index finger of the left hand is then passed into the vagina and carried upwards until the blunt point of the knife is felt above the symphysis. The division of the cartilage is then made from above downwards, the resulting separation of the bones being observed by the finger in the vagina. A sound should be passed into the bladder and the urethra displaced as much as possible to one side during the operation. The child is then delivered, and the operation completed by the application of an antiseptic dressing and a pelvic binder.

Although symphysiotomy is an easy and simple operation, its results are disappointing, for the following reasons :

(1) injury to bladder and urethra often occurs ; (2) the space behind the pubic bones (*cavum Retzii*) is difficult to drain, and when accumulations of fluid occur there they easily become infected ; (3) after the operation has been successfully performed it may prove impossible to deliver the child except by craniotomy ; this is explained by the difficulty of estimating the degree of disparity between the head and the pelvis.

Prognosis.—Statistics of this operation, compiled by Munro Kerr from 275 cases by well-known operators, show a maternal mortality of 6·5 per cent. and a fœtal mortality of 10 per cent. That is to say, the mortality is greater both as regards the mother and the child than that of uncomplicated Cæsarean section. The complications most likely to be met with are injuries to the urethra or bladder, and septic infection of the operation wound. Firm union of the symphysis almost always occurs, but some cases of temporary and some even of permanent lameness have been reported.

Pubiotomy : Hebotomy. — This operation resembles symphysiotomy in its general features, and the indications for its performance are the same. Instead of dividing the symphysis pubis, the body of the pubic bone is divided about $\frac{1}{2}$ to $\frac{3}{4}$ of an inch to one or other side of the joint. It is claimed that this operation allows of greater increase in the diameters of the brim than symphysiotomy, and further that the pelvis is *permanently* enlarged by it. Whitridge Williams has shown that the effect of pubiotomy upon the diameters of the outlet is well marked also, and that the operation is therefore serviceable in the funnel pelvis. He observed a *permanent* increase in the transverse diameter of the outlet of from 1 to 3 cm. in funnel pelves which had been subjected to this operation. It is also claimed that there is not the same risk of injuring the urethra.

Pubiotomy may be performed by the open or the subcutaneous method. In the *open method* a vertical incision is made just internal to the pubic spine (to avoid the external inguinal ring), and about 3 inches in extent. It may be made upon either side, and is carried down to the anterior surface of the bone. Next the rectus sheath is divided and the finger is passed down behind the pubic bone to the lower

border of the pubic arch. A curved metal hook or carrier is then entered above, directed behind the bone by the finger, and brought out below it in front. With the aid of the carrier a Gigli's saw is passed and the bone divided. Formidable hæmorrhage may occur from the subcutaneous tissues and from the pelvic cellular tissue, and from the corpus cavernosum which is necessarily injured by the saw.

In the *subcutaneous method* a small incision, about an inch in length, is made just above and internal to the pubic spine, and a special curved pubiotomy needle is passed behind the bone and made to emerge below the pubic arch by piercing the soft tissues in that position. Through the needle a piece of stout silk is threaded, with which Gigli's saw is drawn up behind the bone, and brought out at the supra-pubic incision.

The late results of pubiotomy are not unfavourable. The bones reunite by fibrous union only, but this does not interfere with locomotion, and a certain amount of permanent increase in the pelvic diameter has been repeatedly observed.

The operations of symphysiotomy and pubiotomy have not been extensively adopted in this country, although several short series of cases have been recorded by British operators. Conditions in which they are indicated can also be dealt with by Cæsarean section, and this operation is usually preferred for the reasons already stated.

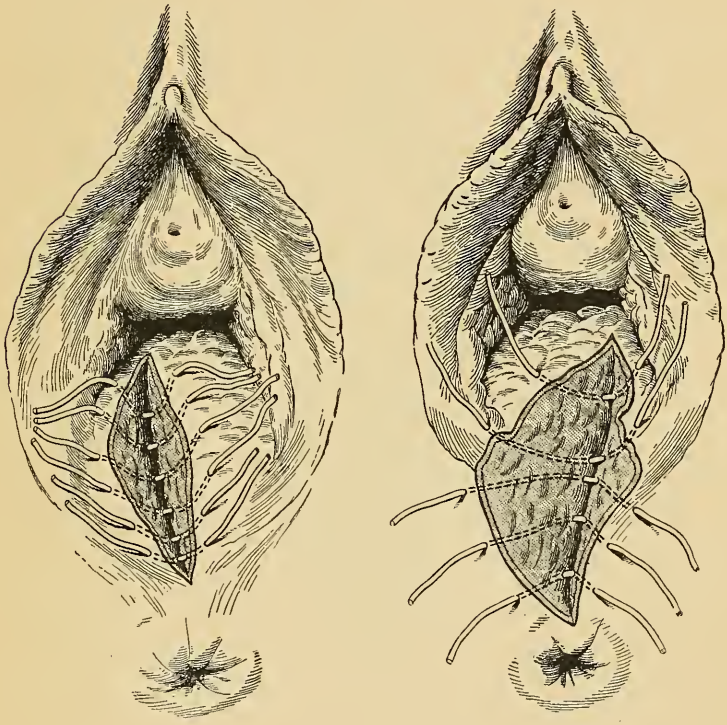
Both operations are more formidable than Cæsarean section, and it has still to be shown whether they possess any compensating advantages.

Primary Repair of the Perineum

All obstetric lacerations of the perineum exceeding ½ inch in depth should be repaired immediately. Such lacerations heal well if repaired at any time within forty-eight hours after delivery. Primary union can be obtained if surgical cleanliness is observed; but when lacerations are allowed to remain unsutured they frequently become infected during the puerperium, and may later on lead to the occurrence of prolapse or rectal incontinence.

Three types of laceration may be described. In the *first*,

which is usually overlooked, the laceration at first sight appears to involve only the anterior edge of the perineal body ; if, however, the vulva is held open with the fingers it will be seen that a comparatively deep laceration runs upwards and somewhat outwards into the vaginal wall on one or both sides (Fig. 353, *a*). If this apparently trivial



a *b*

Fig. 353.—Perineal Laceration : *a*. First Type. *b*. Second Type. (Edgar.)

tear is neglected, it may lead subsequently to the condition of relaxed vaginal outlet and prolapse of the vaginal walls, for it is frequently deep enough to affect the posterior fibres of the levator ani and the anal fascia, which support the posterior vaginal wall. It should be repaired with interrupted catgut stitches, as shown in the figure.

In the *second* type the laceration involves the greater part of the perineal body and a considerable part of the posterior

vaginal wall, but the anus and its sphincter escape. This type is sufficiently obvious to be generally recognised and sewed up. It is best repaired by a series of sutures introduced, some through the perineum and some through the posterior vaginal wall (Fig. 353, *b*); this is preferable to

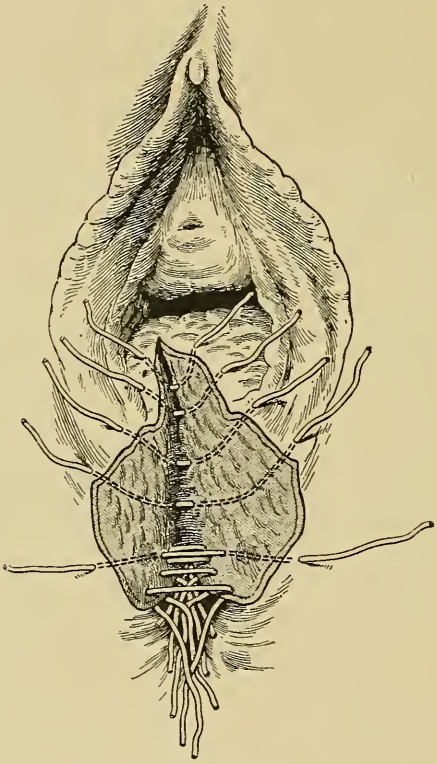


FIG. 354.—Perineal Laceration: Third Type. (Edgar.)

Note that the skin suture has passed through the torn ends of the sphincter ani muscle.

passing them all through the perineal surface and endeavouring to include the upper end of the vaginal rent, for accurate apposition of the edges of the vaginal mucous membrane, so necessary for a good result, cannot be obtained in this way. Strong catgut is the best suture material.

In the *third* type, posterior vaginal wall, perineal body, and anus are all torn through, establishing direct communi-

cation between the vagina and rectum (Fig. 354). This severe laceration requires very careful treatment, or the patient will suffer from incontinence of fæces. The edges of the rectal mucous membrane are first carefully united by a series of interrupted catgut stitches, which must be tied on the rectal side. Then the torn edges of the posterior vaginal wall are united in the same manner; and lastly deep sutures of silkworm-gut are passed through the perineal surface, the lowest of which should include the divided and retracted ends of the sphincter ani muscle.

When the delivery has occurred with the patient under the influence of chloroform, perineal sutures may usually be introduced immediately, before the anæsthesia passes off, without waiting for the expulsion of the after-birth. The sutures should be clamped in position by artery forceps and only knotted when the after-birth has been delivered; otherwise, if digital removal of the placenta should become necessary, the operation would have to be repeated. This obviates the necessity of giving more chloroform in order to pass the sutures when the third stage is over. In severe lacerations involving the rectum, it is better to wait until after the delivery of the placenta before beginning the operation, as considerable time is required in passing the sutures.

The patient should be placed in the lithotomy position, and the parts well exposed, for accurate suturing is essential. Although considerably bruised and torn, the parts heal well if properly adjusted with stitches.

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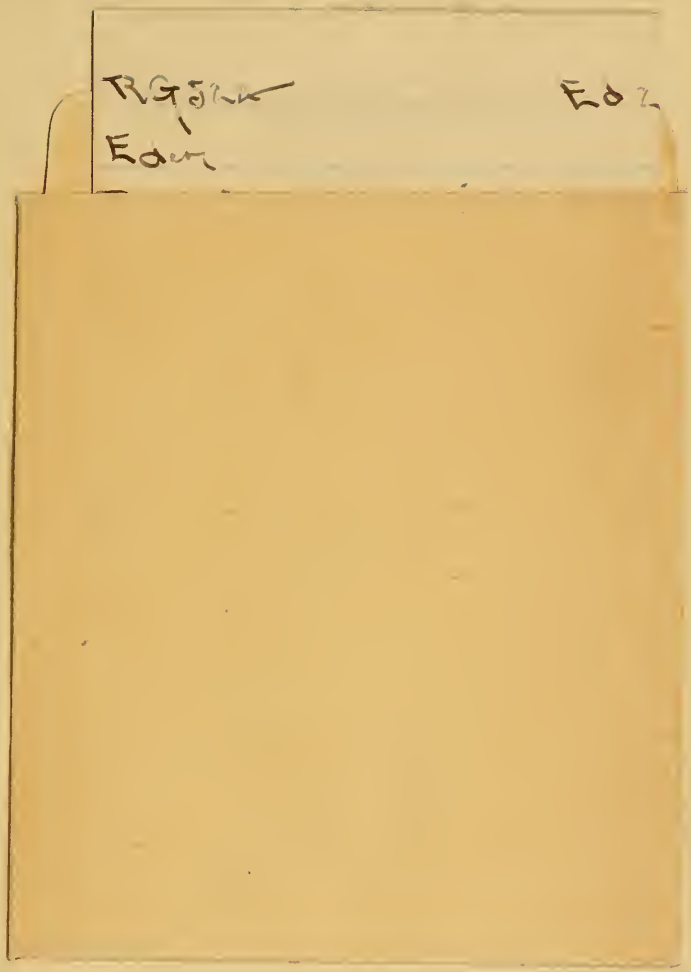
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